PRECAMBRIAN ROCKS OF SOUTHEASTERN ARIZONA

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INTRODUCTION

The major subdivisions of Precambrian rocks in southeastern Arizona include an older crystalline complex, consisting dominantly of the Pinal schist and associated granitic bodies, and an overlying sequence of sedimentary rocks, the Apache group. The two divisions are separated from each other and from the Paleozoic section by major unconformities. The Pinal schist and Apache group have been correlated with Archean and Algonkian rocks elsewhere, but currently they are usually designated as older and younger Precambrian in age.

OLDER PRECAMBRIAN PINAL SCHIST

Distribution

The older Precambrian Pinal schist was named by Ransome (1903) for exposures in the Globe district. The formation was extended to the Bisbee area (Ransome, (1904), the Clifton-Morenci area (Lindgren, 1905) and into the Ray area (Ransome, 1919). Recent work has continued to use the name to describe Precambrian schist in the Little Dragoon Mountains (Anderson, 1951; Cooper and Silver, 1954; Cooper, 23), central Cochise County (Gilluly, 1956) and in the Dos Cabezas and Chiricahua Mountains (Sabins, 1957b). The location of major outcrops considered to be older Precambrian are shown by Anderson (1951) but some of the outcrops shown have been referred to the Pinal on the basis of lithologic similarity and may be younger and some may represent granitic gneiss which is in part of debatable age.

Description

The Pinal schist ranges in texture from aphanitic to coarsely crystalline and the over-all color is light greenish gray, with frequently a satiny luster. The formation consists chiefly of muscovite-quartz and chlorite-muscovite-quartz schist with local units composed of quartzite, amphibolite, and feldspathic schist. Mineralogically, most of the Pinal consists of quartz and sericite or muscovite with zircon, tourmaline. hornblende, biotite, magnetite and chlorite present as accessory minerals. Locally, gneissic facies and andalusite and sillimanite occur near granitic intrusions.

In the Dos Cabezas Mountains, Sabins (1957b) mapped one prominent quartzite member separately to show details of Precambrian structure. This quartzite bed is seen at mile 220. 3 on the second day road log for Field Trip V, where it defines a steeply plunging syncline in the older Precambrian rocks.

Origin and Thickness

The Pinal schist is generally considered to be the metamorphosed equivalent of a sequence of sedimentary rocks with minor amounts of volcanic material. Ransome (1904) suggested that the Pinal in the Bisbee area was originally composed of arkosic sand and silt. The thicknesses of the original sequence of rocks making up the Pinal schist are generally described as in the magnitude of "many thousands of feet" (Gilluly, 1956). Cooper and Silver (1954) concluded from their work in the

Dragoon quadrangle that the Pinal schist originally consisted of 9,000 to about 20,000 feet of sedimentary and volcanic rocks that represent a eugeosynclinal accumulation in a major geosynclinal trough whose limits have not yet been determined.

Age and Correlation

The Precambrian age of the Pinal schist is demonstrated by its position beneath Apache group or early Paleozoic sediments. The Pinal schist of southeastern Arizona is similar in many respects to the Yavapai schist of central Arizona and the Vishnu schist of the Grand Canyon district, although less amphibolite and gneiss are reported from the Pinal. The three formations also contain evidence of similar structural histories and in each area a long period of accumulation of sedimentary and volcanic rocks was terminated by a major compressive orogeny accompanied by the implacement of granitic intrusions.

Many bodies of schist have been referred to the Pinal on the basis of lithologic similarity. Butler and Wilson (1938) pointed out that schistose rocks are not necessarily of older Precambrian age and also that the coarse texture of igneous rocks was not necessarily an indication of pre-Paleozoic age. Gilluly (1956) points out that several exposures mapped as Pinal schist in central Cochise County may represent metamorphosed sediments of Cretaceous age. The age of strongly banded gneiss, often considered to be Precambrian, is discussed in connection with Field Trip III (DuBois, 19; 20).

Intrusive Rocks

Igneous bodies of older Precambrian age intrude the Pinal schist in many areas. These bodies include albite granite, granite, quartz monzonite, quartz diorite, and diorite, and most were emplaced after the Precambrian orogeny. Some are gneissose and in the Dos Cabezas Mountains, Sabins (1957b) concluded that the Precambrian gneissose granite was deformed contemporaneously with the Pinal. Aplite dikes of older Precambrian age cut all of the other Precambrian rocks in many areas. The older Precambrian intrusive bodies are generally smaller than the intrusive bodies of post-Paleozoic age.

Structure

The structural trends in the Pinal schist are dominantly northeast (Ransome, 1904; Cooper and Silver, 1954) although Gilluly (1956) reports possible east to northeast trends in central Cochise County and in the Chiricahua and Dos Cabezas Mountains the dominant structural trends are northwest (Sabins, 1957b). Ransome (1904) and Sabins (1957b) report that the foliation of the schist is apparently parallel to the original stratification.

The orogeny that deformed the older Precambrian in central Arizona is termed the Mazatzal Revolution (Wilson, 1939). He suggested that the Mazatzal Revolution was responsible for the metamorphism of the Vishnu and Pinal schists and Anderson (1951) supports this view. The detailed history of the older Precambrian rocks in southeastern Arizona is not so well known as is that of similar rocks in central and northern Arizona because exposures are smaller and more discontinuous, subsequent structural and igneous events have been more complex and fewer detailed studies have been made.

EP-ARCHEAN UNCONFORMITY

The Pinal schist is separated from younger Precambrian rocks by a nearly featureless surface. In central and northern Arizona the ep-Archean surface (Hinds, 1936; Sharp, 1941) rarely has more than 50 feet of relief in many miles, and correlation of this surface throughout the state appears to be justified. The probable thickness of overburden through which this period of erosion penetrated and the remarkable lack of relief of the final surface suggest a long and unique period of erosion whose significance, if not its features, is anything but monotonous.

YOUNGER PRECAMBRIAN ROCKS

The younger Precambrian Apache group of central and southeastern Arizona was named by Ransome (1903) from the Globe quadrangle. The Apache group rests on the ep-Archean surface and consists of conglomerate, shale, quartzite, limestone and tuff, locally overlain by basalt flows. These rocks are exposed in a belt trending generally north from northern Cochise County to the Mogollon Rim, with isolated outcrops as far west as the Vekol Mountains (McClymonds, 16). No younger Precambrian rocks are present in the Pine-Payson area or in the few drill holes that have penetrated granite between the Mogollon Rim and the Grand Canyon.

Description

The Apache group is relatively uniform throughout its areas of exposure, although individual formation may be missing due to faulting, erosion, or non-deposition. Five formations are recognized in the group, from oldest to youngest, the Scanlan conglomerate, Pioneer shale, Barnes conglomerate, Dripping Spring quartzite and Mescal limestone (Ransome, 1903, 1915, 1916). The Troy quartzite was originally assigned to the Apache Group (Ransome, 1915, 1916) but was later separated on the basis of Cambrian fossils (Darton, 1932; Stoyanow, 1956). Shride (1958) suggests that quartzite originally called Troy in some of the northern areas of Apache group exposures may actually be Precambrian.

The Scanlan conglomerate contains imperfectly rounded pebbles set in an arkosic or micaceous matrix and grades upward into the Pioneer shale. Locally, the Scanlan conglomerate is absent and its thickness rarely exceeds 15 feet.

The Pioneer shale is composed of maroon shale and grayish-red purple to light brownish gray, medium to fine-grained quartzite. Individual beds range in thickness from one to six feet and are separated by shaly partings or thin, ripple-marked layers of siltstone. Light-colored bleached spots are typical in the Pioneer in many exposures. Gastil (1954) reports rhyolite tuff and tuffaceous siltstone in 9 out of 12 sections measured between the Ray and Pine-Payson areas. Recently, the Pioneer shale has been redesignated the Pioneer formation (Peterson and others, 1951). It ranges in thickness from about 150 to 400 feet.

The Barnes conglomerate is typically composed of well rounded, ellipsoidal pebbles of quartzite, quartz, and red jasper, commonly 2 to 4 inches in diameter. They are set in a coarse, arkosic, silica-cemented sand that grades upward into the Dripping Spring quartzite. The Barnes ranges from 0 to 50 feet in thickness.

The lower part of the Dripping Spring quartzite is typically light to brownish gray, with alternating beds of quartzite and siltstone above in red, purple, and black bands. The formation is typically feldspathic, ranging from arkosic quartzite to

sandy siltstone, and is thinly to thickly bedded. The Dripping Spring quartzite ranges from less than 400 to about 800 feet in thickness.

The Mescal limestone is the top sedimentary formation of the Apache group. Bromfield and Shride (1956) recognized 3 members in the Mescal limestone on the San Carlos Indian Reservation. Gray to buff cherty limestone and dolomite form the lower member; the middle member is made up of massive, cliff-forming algal limestone; and silty and siliceous beds with thin-bedded gray limestone compose the upper member. On the San Carlos Reservation, the formation is up to 350 feet thick.

An unnamed sandstone between the Dripping Spring and Cambrian Troy quartzites in the Santa Catalina Mountains was believed by Stoyanow (1936) to occupy the position of the Mescal limestone. Subsequently, the sandstone was assigned to the Cambrian by Wallace (1954). The Mescal limestone is missing in many areas in central Arizona. Locally, the Mescal is overlain by a thin basalt flow or a series of flows, typically 50 to 100 feet thick. The basalt is of younger Precambrian age and may be overlain by the Troy quartzite. In some places, the Mescal limestone has been split and dilated by diabase sills which have localized the commercial asbestos deposits typical of the region. Large bodies of the diabase may be Mesozoic or Tertiary in age (Peterson, 1954), or may be pre-Devonian (Bromfield and Shride, 1954; Shride, 1958).

Conditions of Deposition

The extent of the basin in which the Apache group was deposited is not known, but from the Globe and Salt River Canyon areas the sequence thins in all directions except west. The group thins rapidly east and south of the Salt River area by erosion at the top and by thinning of some individual units (Bromfield and Shride, 1954). Among the most southerly exposures of the group are those in the Santa Catalina and Little Dragoon Mountains where the sections are about 700 and 600 feet thick, respectively. In the Little Dragoon Mountains, Enlows (1939) notes a general thinning of each formation to the southeast.

In a reconnaissance of several of the southerly exposures of the Apache group, Bruhn (1927) concluded that the basin in which all the units were deposited sloped to the northwest. In the Vekol and Slate Mountains (McClymonds, 16), the Apache group is about 1, 500 feet thick and no limit can be set to the Apache basin on the west.

PRE-MIDDLE CAMBRIAN UNCONFORMITY

In most places in central and southern Arizona, sedimentary rocks of Middle Cambrian age rest with either an erosional disconformity or a slight angular discordance on an erosion surface of low relief cut on the Apache group. Local pre-Paleozoic basalt flows and diabase intrusions suggest some pre-Paleozoic deformation of the Apache group, but in general there appears to have been no major orogeny in central and southeastern Arizona corresponding to the Grand Canyon disturbance in the northern part of the state.