The American Association of Petroleum Geologists Bulletin
V. 54, No. 2 (February, 1970), P. 275-284, 7 Figs.

Paleozoic Stratigraphy of Toiyabe Range, Southern Lander County, Nevada[1]

ROBERT H. WASHBURN[2]
Huntingdon, Pennsylvania 16652

Abstract A sequence of Paleozoic sedimentary rocks, ranging in age from Cambrian to Carboniferous, was deposited in a transitional zone between the mio- and eugeosynclinal belts and now is exposed in a large area of the central Toiyabe Range south of Austin, Nevada. A maximum of 3,250 ft of quartzite, graywacke, and some limestone constitutes the Gold Hill Formation. Archaeocyathids (*Archaeocyathus atlanticus* Billings and *Ethmophyllum whitneyi* Meek), locally abundant at the top of the lower Gold Hill Formation, indicate an Early Cambrian age. The Cambro-Ordovician Broad Canyon Formation (new name), consisting of intensely deformed limestone, argillaceous siltstone, and phyllite, is about 2,000 ft thick. Antelope Valley Limestone, up to 800 ft thick, contains the *Palliseria* assemblage (Middle Ordovician) near the top in two areas. Remnants of the Silurian Masket Shale (Roberts Mountains Formation) overlie the Antelope Valley with regional disconformity. Devonian corals are present in a massively bedded limestone overlying the Masket in one locality. A Tertiary conglomerate preserves boulders of coralline limestone and chert pebbles of the Carboniferous Wildcat Peak Formation.

An allochthonous sequence lies tectonically above and next to the transitional succession which is considered to be autochthonous. It consists mainly of Paleozoic chert and argillite about 10,000 ft thick, and, in one small area, of volcanic rocks, chert, and siltstone, perhaps of the Charcoal Canyon Formation. Only poorly preserved radiolarians have been found in these rocks.

Introduction

Autochthonous and allochthonous sequences of Paleozoic sedimentary rocks are exposed in large areas of the central Toiyabe Range south of Austin, Nevada (Fig. 1). The three distinct facies of Paleozoic rocks which have been described in the Great Basin—the eastern carbonate belt, the western chert and volcanic belt,

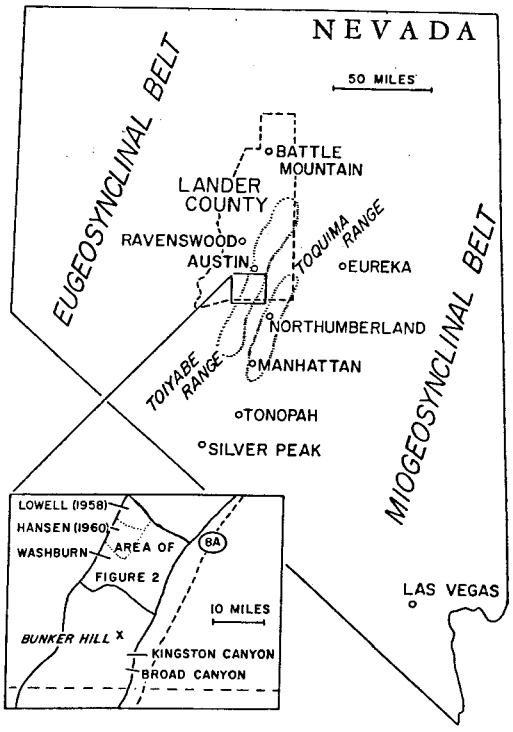


FIG. 1.—Index map showing location of Lander County, Nevada, and Toiyabe Range.

and a transitional belt between the two—are present (Roberts *et al.*, 1958). Similar lithic units have been described in the southern Toiyabe and Toquima Ranges by Ferguson (1924) and Ferguson and Cathcart (1954), in the Toiyabe Range by Means (1962) and Stewart and Palmer (1967), in the Toquima Range by Kay and Crawford (1964), and in the Battle Mountain area by Roberts *et al.* (1958).

Autochthonous Strata

Strata which appear to be autochthonous or parautochthonous range in age from Cambrian to Devonian and consist of siltstone, quartzite, argillite, and limestone. The Cambrian and Ordovician sediments were deposited in the transi-

[1] Manuscript received, September 9, 1968; accepted, February 17, 1969.

[2] Department of Geology, Juniata College.

I am indebted to Marshall Kay, who suggested this research and gave freely of his time and knowledge. I also thank J. H. Stewart, U.S. Geological Survey, who read the manuscript and offered numerous suggestions, F. J. Kleinhampl, also of the U.S. Geological Survey, and D. B. MacLachlan of the Pennsylvania Geological Survey for helpful discussions in the field. W. A. Oliver, Jr., of the U.S. National Museum and C. W. Merriam of the U.S. Geological Survey very kindly studied the Devonian corals; their help is gratefully acknowledged. The field work was supported by the Geology Department, Columbia University.

tional environment as defined by Roberts *et al.* (1958). The Silurian and Devonian calcareous shale and carbonate rocks are part of the eastern carbonate environment.

Cambrian and Ordovician Systems

In this part of the Toiyabe Range, the Cambrian and Ordovician strata bear little similarity to those of the eastern Great Basin. The only stratigraphic unit common to the Toiyabe Range and the eastern Great Basin is the upper part of the Pogonip Group (Antelope Valley Limestone). The older stratigraphic units may be compared best with the rocks on the south. Rocks similar to the Palmetto Formation in the southern Toiyabe Range (Ferguson and Cathcart, 1954) and the Perkins Canyon Formation in the Toquima Range (Kay and Crawford, 1964) are present in the mapped area. These rocks, constituting the Broad Canyon Formation named herein, represent the transitional facies. The Lower Cambrian Gold Hill Formation of the southern Toiyabe and Toquima Ranges also crops out in the central Toiyabe Range.

Gold Hill Formation

Lower Cambrian strata, metamorphosed in part, crop out along the Summit Ridge from Rock Canyon to Frenchman Creek, at the foot of the range at Globe Canyon, and along Spanish Canyon (Fig. 2). In each area, the rocks exposed have certain unique aspects, but they all have been assigned to the Gold Hill Formation.

Summit Ridge section.—The most informative section is along the Summit Ridge; 3,250 ft of continuous section is exposed in Crooked Canyon from the range fault (altitude 8,400 ft) to the summit of the range (altitude 10,800 ft) in a west-dipping limb of a major north-south-trending anticline. The section has been divided into seven units (Fig. 3). The lowest unit, terminated by the fault, is 120 ft of limestone. The next 500 ft is mudstone interbedded with quartzite and graywacke. The third unit is white quartzite, a prominent cliff former, 230 ft thick. About half of the total section, unit 4, is fine-grained graywacke with quartzite and mudstone interbeds. Unit 5, a slope former that is distinctive in color, consists of 80 ft of buff-weathering limestone, with locally abundant archaeocyathids. Above (unit 6) is 400 ft of mainly mudstone, the middle 100 ft consisting of limestone and quartzite. Some of the limestone contains *Girvanella*-like structures. The uppermost unit (7), capping the range, is persistent blue limestone, 330 ft thick.

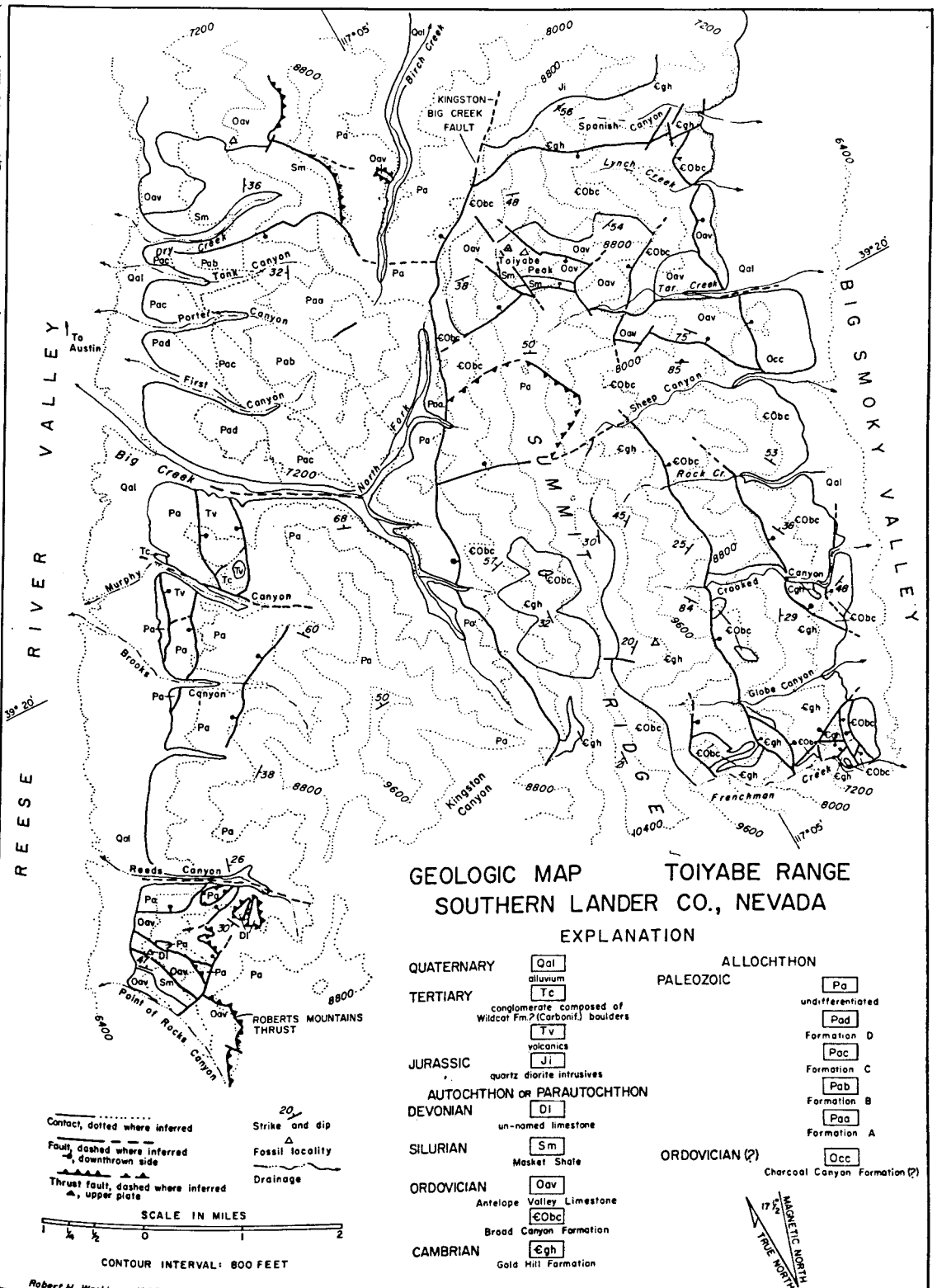
Globe Canyon section.—A second section was measured on the south side of Globe Canyon (Fig. 2) near its mouth; 642 ft of continuous section is exposed in a broad anticline paralleling the trend of the range. It is possible to recognize in this section, with varied degrees of certainty, the lower six units of the Summit Ridge section (Fig. 4), although each unit is thinner and the total thickness visibly decreases westward. The blue limestone, unit 7, crops out above unit 6 on the next ridge south and on a dip slope between the top of the section and the next ridge. It was not measured because the contact is locally faulted. However, on the north side of the canyon the section appears stratigraphically continuous near the top, though generally it is less well exposed.

In both measured sections the buff-weathering limestone, unit 5, is the most consistent and easily traced unit. There is a conspicuous absence of mudstone at Globe Canyon, and an abundance of limestone interbeds.

Spanish Canyon section.—The preceding sections show little evidence of metamorphism. However, in Spanish Canyon, the northernmost canyon mapped on the east side of the range, a sequence of quartzite and graywacke is interbedded with dark-red, brown-weathering, spotted and micaceous schist. These sedimentary and metasedimentary rocks are essentially vertical in a tight anticline striking along the canyon. On the north the metasedimentary rocks are in contact with the Austin pluton. Scapolite-garnet marble derived from limestone is present on the ridge at the head of the canyon. Near the foot of the range between Spanish Canyon and the next canyon south, a blue limestone similar to unit 7 crops out.

Age.—Archaeocyathids are present in Lower Cambrian rocks in the southern Great Basin, Nevada and California (Stewart, 1966), and the Lower and/or Middle Cambrian near Battle Mountain, Nevada (Roberts, 1964; Roberts *et al.*, 1958). These fossils, which are charac-

FIG. 2.—Geologic map of Toiyabe Range, modified from Washburn (1966).



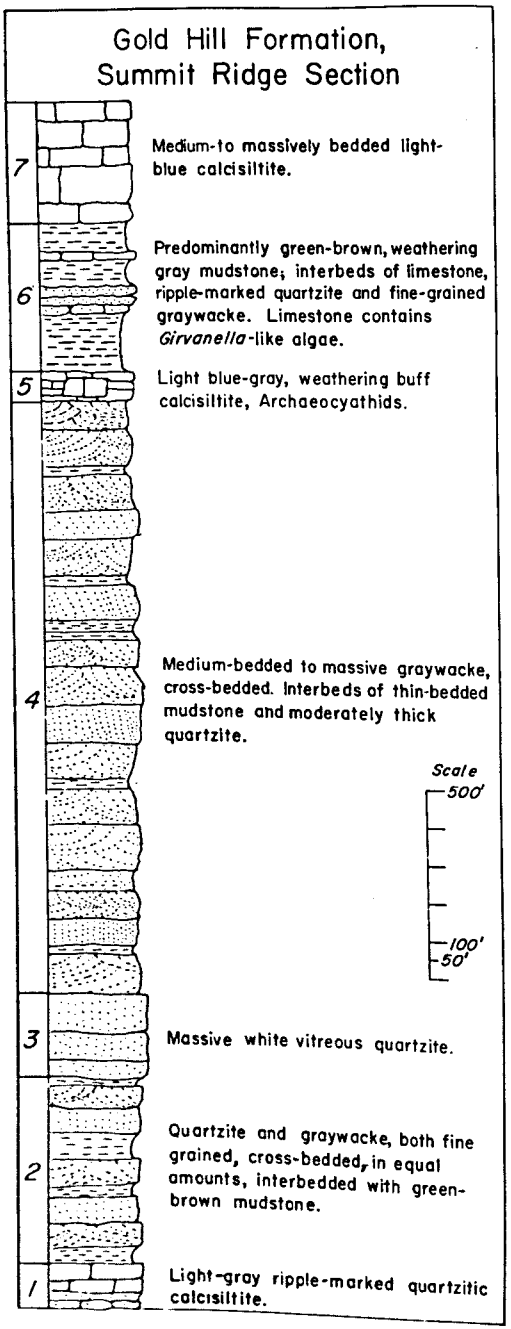


FIG. 3.—Stratigraphic section of Gold Hill Formation measured above Crooked Canyon at elevation 8,400–10,800 ft on Summit Ridge of Toiyabe Range.

teristic of the Lower Cambrian, commonly form a major part of the buff-weathering limestone, unit 5, on the Summit Ridge (Fig. 5). *Archaeocyathus atlanticus* Billings and *Ethmophyllum whitneyi* Meek are abundant in the thin-bedded calcisiltites and quartz-silty calcisiltites, whereas *Cambrocyathus* sp. and *Cambrocyathus* sp. cf. *C. occidentalis* Okulitch are scarce. Ghosts of archaeocyathids are present in a massive, 5-ft-thick, recrystallized reeflike limestone bed.

According to Palmer (1956, p. 676), archaeocyathids form a poorly defined faunal facies in the Cambrian rocks of the Great Basin. This opinion was based on the three fossil locations known at that time, and on the absence of these fossils in the numerous well-studied Cambrian sections in the eastern Great Basin; the facies is restricted to the western Great Basin. The new locality in the Toiyabe Range and several other new archaeocyathid localities summarized by Stewart (1966), well within the limits of Palmer's western faunal province, help to substantiate and define this faunal province.

The only other fossils found in these rocks are *Girvanella*-like algae and imprints of worms or algae on some quartzite bedding planes. Therefore, the only age determinations which can be made are for unit 5 and lower units which are assigned to the Early Cambrian.

Correlation.—These sections can be compared with several well-known Cambrian sections in the Great Basin. The Cambrian strata most similar to these are in the Gold Hill Formation described by Ferguson (1924) and Ferguson and Cathcart (1954) near Manhattan, Nye County, Nevada, in the Toquima and Toiyabe Ranges. In the Toiyabe Range a few miles south of the study area, Means (1962) de-

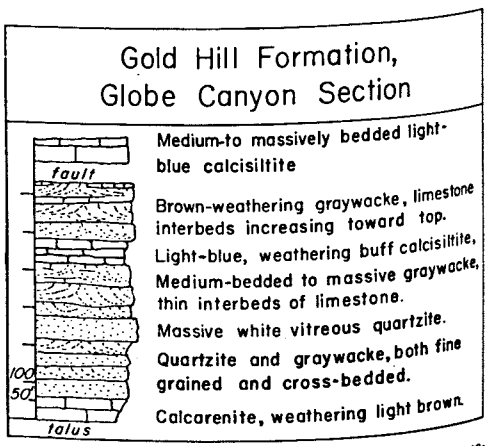


FIG. 4.—Stratigraphic section of Gold Hill Formation measured on south side of Globe Canyon ½ mi above mouth.

scribed a section which he called the Clear Creek sequence that appears to contain similar strata. The Gold Hill Formation and the Clear Creek sequence also include schistose slate, quartzite, and sandstone, much the same as those found in Spanish Canyon. Large plutons are present near or adjacent to each locality. The sections at Summit Ridge and Globe Canyon differ in that they are unmetamorphosed.

The Globe Canyon and Summit Ridge sections differ in thickness and lithology. Although the coarser terrigenous units can be correlated in both sections, Summit Ridge is characterized by an abundance of mudstone, whereas the Globe Canyon section has little mudstone and is generally calcareous throughout. These two sections are separated by a high-angle fault, and the lateral relations cannot be observed.

The proximity of these differing sections can be explained in two ways. First, they may be laterally and temporally equivalent, once having been continuous across the high-angle fault, but a marked thinning and facies change is involved between sections. Second, one or both sections may have been transported to the present site (parautochthonous or allochthonous) and they may be in different thrust-slice sequences. If so, they would represent the same lithic interval, but would not necessarily be synchronous.

The second possibility seems most likely upon comparison of the sequences of rocks. The upper three units correlate well, although no archaeocyathids have been found in unit 5 at Globe Canyon. The similarity in the sequence of rock types in the other units also suggests that the two sections may correlate. This possibility could be proved if the thrust at the base of the transported sequence were found. No thrust has been located in the area mapped.

The first possibility seems less likely because of the marked differences in thicknesses, and because the Globe Canyon section thins in the wrong direction. Moreover, although certain lithic units can be correlated, the predominance of carbonate in one section and mudstone in the other is puzzling.

It is also possible that the two sections are not lithically or temporally related.

These sections are considered to be the Gold Hill Formation because of the lithic similarity with the type Gold Hill and because both are of Early Cambrian age.

Depositional conditions.—Cross-bedding is common and ripple marks are locally abundant in the siltstone and sandstone. Most sediments are relatively well sorted, in that only the finest grain sizes are present. Grains are mostly angular but some are subrounded. Increasing roundness varies inversely with feldspar content and appears independent of grain size. Quartz is by far the dominant mineral in all of the clastic rocks. Where feldspar is present, it is generally sodic plagioclase, although some microcline occurs. All feldspars are fresh in appearance.

The presence of archaeocyathids and archaeocyathid reefs indicates that part of the formation was deposited in very shallow water. Current directions, based on meager data (Fig. 6), are divided about equally between N35°E and S30°W, roughly parallel with the direction of the long axis of the geosynclinal belt.

Broad Canyon Formation (New Name)

Means (1962, p. 76) introduced the name Broad Canyon sequence for "a sequence of dark slates, phyllites, and argillites which overlies the Clear Creek sequence," after exposures in Broad Canyon, the first canyon south of Kingston Canyon, Toiyabe Range, in southernmost Lander County, Nevada. Herein it is considered a formation.

The Broad Canyon Formation is exposed in Lynch, Sheep, Rock, and Crooked Canyons and along the Summit Ridge (Fig. 2). A complete section does not seem to be present in any one locality. The formation can be divided into three members. The lowest is composed of interbedded limestone and argillite and minor siltstone. It is easily accessible along the old mine road in Lynch Canyon. This member grades into the middle member as the limestone beds decrease in number. The middle member is dark argillite with silty bedding laminations. The highest member is gunmetal-blue phyllite. The boundary between the middle and upper members is placed where the bedding, as indicated by the silt laminations, becomes indistinguishable. This change is observed best along the north side of Rock Canyon. The whole formation has been folded severely, and its true thickness has not been determined. However, it is in the order of 2,000 ft. The base of the Broad Canyon Formation is exposed best in Crooked Canyon about 0.8 mi above the mouth. There its contact with the Gold Hill Formation appears to be conformable. The upper contact of the Broad Canyon Formation is seen best 0.4 mi north of Toiyabe Peak on the Summit Ridge. The overlying Pogonip limestone appears to grade downward into the Broad Canyon phyllite.

Age and correlation.—No fossils have been

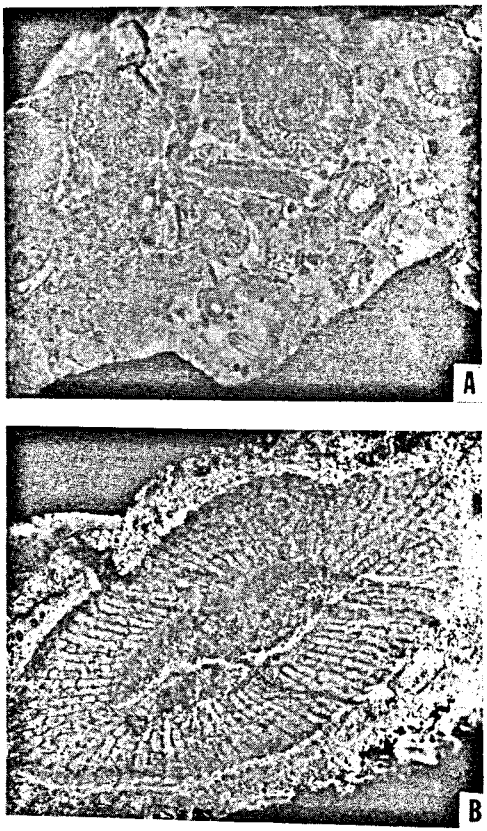


FIG. 5.—Photographs of rock sections from Gold Hill Formation between Crooked and Globe Canyons at altitude of 10,600 ft. A. Polished section of archaeocyathid limestone. Two large specimens near top are *Archaeocyathus atlanticus;* others are *Ethmophyllum whitneyi.* Actual size. B. Polished section of *Cambrocyathus* sp. cf. *C. occidentalis* showing inner and outer walls and radial septa. Actual size.

found in the Broad Canyon Formation. As its contacts with the underlying Gold Hill Formation and the overlying Antelope Valley Limestone (Chazyan) appear to be conformable, it is dated as Middle Cambrian through Early Ordovician.

Lower Paleozoic rocks similar to the Broad Canyon are present in the southern Toiyabe Range and in the Manhattan and Northumberland districts, Toquima Range. These strata may be in different thrust sequences and details of their stratigraphic relations have not been determined.

Depositional conditions.—The fine-grained terrigenous and calcareous sediments of the Broad Canyon Formation indicate a distant and probably noncratonic source and/or quiet tectonic conditions. The absence of ripple marks and cross-laminations, and the presence of fine laminations probably indicate deposition in deep water.

Antelope Valley Limestone

In the study area the Antelope Valley Limestone is exposed at Toiyabe Peak and Dry Creek. Its base is exposed only in the vicinity of Toiyabe Peak and eastward along the ridge between Lynch and Tar Creeks. In this area the Antelope Valley appears to lie conformably on the Broad Canyon Formation. The two formations are in an east-trending syncline overturned on the north. Just south of Toiyabe Peak in the core of the syncline, the Masket Shale (Silurian) disconformably overlies the Antelope Valley, which has a total thickness of less than 800 ft.

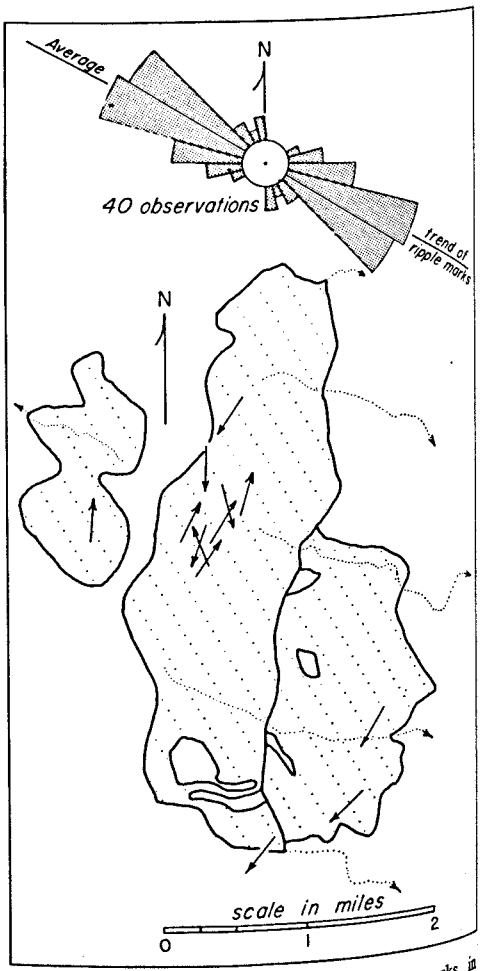


FIG. 6.—Current directions from ripple marks in Gold Hill Formation outcrop area.

The Antelope Valley Limestone can be divided into four members (Fig. 7). Abundant macluritid gastropods, *Receptaculites,* and orthid brachiopod fragments are present about 600 ft above the base. Lowell (1958, p. 82) has described the formation in the Dry Creek area, where about 400 ft of limestone is exposed. The lower 300 ft is platy, thin-bedded calcisiltite. The upper 100 ft is coarser and contains *Palliseria, Maclurites,* and *"Girvanella."* The Masket Shale overlies this fossil zone.

Antelope Valley Limestone also is present in the area of Bunker Hill and forms the summit of the mountain itself (D. MacLachlan, personal commun. 1962).

Age and correlation.—The shelly fauna preserved at Dry Creek and Toiyabe Peak is characteristic of the *Palliseria* beds of the Antelope Valley Limestone. The limestone beds in the Toiyabe Range appear more argillaceous and much less fossiliferous than the type Antelope Valley. There is doubt of the synchroneity of the *Palliseria* zone in the Great Basin. Ross (1964, p. 1540) believed that it is facies-controlled and becomes younger toward the west.

Means (1962, p. 77, 78) mapped large areas of limestone southwest of Kingston Canyon, which he informally called the Crane Canyon sequence. Late Cambrian trilobites have been reported 5 mi south of Austin from Crane Canyon-like rock types (Stewart and McKee, 1968) which overlie the Clear Creek (Gold Hill Formation) sequence. On the east side of the range near the mouth of Clear Creek, Means mapped a limestone-shale sequence which he called the Eastside sequence. These rocks are in part lithically similar to, but not correlated (by Means) with, the Crane Canyon sequence. The Eastside sequence contains graptolites which, according to Means (1962, p. 79), "... may be correlated with the Copenhagen Formation or, less probably with the upper part of the Antelope Valley Limestone of the Pogonip Group (W. B. N. Berry, personal communication)." The Copenhagen Formation is above the Antelope Valley Limestone in the Antelope Valley region on the east. According to Stewart and McKee (1968), the Crane Canyon sequence and Eastside sequence are above the Kingston Canyon thrust, structurally above the Antelope Valley Limestone and Broad Canyon Formation.

Depositional conditions.—The lack of fossils in the lower part of the Antelope Valley Limestone may be due to deposition in deep water. The fine-grained texture of the pre-*Palliseria* strata and the lack of primary sedimentary structures other than uniform lamination support this impression.

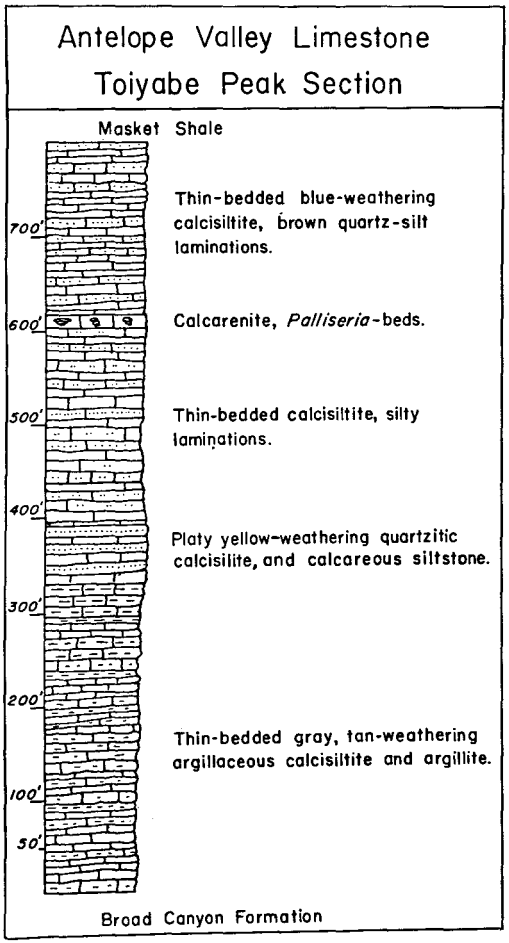


FIG. 7.—Composite stratigraphic section of Antelope Valley Limestone, measured on east side of Toiyabe Peak. Limestone is repeated by faulting; section was broken at *Palliseria* beds.

The gastropod zone represents a lessening of water depth for a short period of time. Younger Ordovician faunal zones may be absent because of a regional discordance between the Ordovician and Silurian Systems indicated by different thicknesses of Antelope Valley Limestone between the *Palliseria* beds and the overlying Silurian Masket Formation.

Silurian and Devonian Systems

Rocks of the Silurian and Devonian Systems in the eastern Great Basin are mostly carbonate. Several thousand feet of stratigraphic sec-

tion may be present. On the west the rocks become terrigenous and the section thins.

Masket Shale

The Masket Shale (Roberts Mountains Formation) overlies the Antelope Valley Limestone at Toiyabe Peak and Dry Creek, and is present in Point of Rocks Canyon. Structural complications and poor exposures preclude an accurate thickness determination in either area. The inferred thickness is similar to that in the type area in the Toquima Range, where 450 ft of argillaceous calcisiltite containing Silurian graptolite faunas has been described (Kay and Crawford, 1964). Graptolites have been reported at Dry Creek (Lowell, 1958, p. 87) and are very poorly preserved in the Masket southeast of Toiyabe Peak; between Reeds and Point of Rocks Canyons, *Retiolites* (?) sp. is present. However, the rocks in each of these areas are relatively unfossiliferous. The Masket is found both above and below the Kingston Canyon thrust.

Devonian Limestone

A coarse calcarenitic patch reef overlying the Masket Shale between Reeds and Point of Rocks Canyons has yielded many corals. W. A. Oliver, Jr., and C. W. Merriam have studied the faunule. Besides *Favosites* sp. and *Alveolites* sp., common to Silurian and Devonian strata, two unique Devonian corals were found. Merriam (personal commun., 1968) identified a new species of *Billingsastraea* similar to *B. nevadensis* (Stumm) and possibly a new genus of a large *Hexagonaria*-like coral. On the basis of the similarity of the newly found *Billingsastraea* to *B. nevadensis*, this limestone can be correlated with the Nevada Limestone, coral zone D_2, which is of late Emsian to early Eifelian (late Early to early Middle Devonian) age.

A second occurrence of Devonian coralline limestone crops out near Dry Creek, where a 2-ft-thick bed is exposed overlying Masket Shale.

These limestones, the westernmost Middle Devonian coralline limestone found in this orthogeosynclinal belt, extend the areal distribution westward at least 50 mi. Stewart and McKee (1968) place these strata at the top of a lower Paleozoic sequence having greater stratigraphic affinity with the eastern miogeosynclinal belt than with the transitional belt, from which it is separated by the Kingston Canyon thrust fault.

Carboniferous and Permian Systems

On the west side of the Toiyabe Range, near the mouth of Murphy Canyon, limestone boulders and multicolored chert-pebble conglomerate are exposed in a Tertiary conglomerate. They are preserved, with Tertiary volcanic rocks, in a downfaulted block. The limestone boulders, some of which are several feet across, contain many corals and some productid brachiopod fragments. Both the limestone and chert are like the Carboniferous Wildcat Peak Formation of the Toquima Range and represent the eroded fragments of this formation, which at one time was present in this area.

Allochthonous Strata

The largest area of allochthonous strata in the Toiyabe Range is on the west side of the Kingston-Big Creek fault (Fig. 2). All the west side of the range from Dry Creek to Reeds Canyon is included. The area bounded by Big Creek, North Fork, Dry Creek, and the Reese River Valley was mapped in detail by J. Hansen (1960), who divided the strata in this area into four conformably formations, A (oldest) through D.

Formation A consists of medium-bedded, dark, subvitreous chert, with green-gray argillite in thin interbeds. A thin-bedded medium-gray argillaceous siltstone, 525 ft thick, is present near the top of the formation. Total thickness is less than 2,700 ft.

Formation B is composed of several rock types, including medium-bedded chert ranging from black to light blue, thin black shale, and graded graywacke-siltstone. Maximum thickness is 2,000 ft.

Formation C is black to dark-blue chert with thin interbeds of dark-gray argillite. Two limestone beds (2–3 ft thick) are present in this unit and are the only carbonate rocks in the sequence. The formation has a maximum thickness of 1,250 ft.

Formation D consists of interbedded argillite and chert. The chert, unlike the chert of the other units, is light green-gray and weathers to rust brown. The argillite is medium gray. The apparent maximum thickness is 4,000 ft.

Outside the area mapped by Hansen, the allochthonous strata were mapped as undifferentiated. However, the light green-gray chert of formation D is probably the most abundant rock type in the area.

On the crest of the Summit Ridge, about 1 mi south of Toiyabe Peak and extending to the

Kingston-Big Creek fault, is another area of allochthonous chert. On the crest itself, the chert is black with gray laminations with some argillite interbeds. The western slope of the Summit Ridge is covered with chert and tan-weathering siltstone, probably the same as in formation A.

Age and correlation.—The only fossils found in the allochthonous strata are very poorly preserved radiolarians; hence the age and correlation of these strata are uncertain. Stewart and McKee (1968) classify them as questionable Valmy Formation (Ordovician). The sequence does contain black shales in which one would expect to find graptolites if it were lower Paleozoic, but none were found in a careful search. Chert sequences similar to these are present throughout the Paleozoic, including the Slaven Chert (Devonian), Schoonover Formation (Carboniferous), Havallah Formation (Middle Pennsylvanian to Permian), and Pumpernickel Formation (Pennsylvanian). These formations contain distinctive fossils which establish, at least partly, their age. Therefore, no age designation other than Paleozoic is given to the allochthonous strata in the Big Creek area.

Clipper Canyon Group?—At the foot of the east side of the Toiyabe Range, between Tar and Sheep Canyons, is a third area of possibly allochthonous strata, mapped in detail by R. Morris (*in* Washburn, 1966). Interbedded laminated siltstone, fine-grained quartzite, and pyroclastic rocks(?) form most of the strata. Thicknesses are indeterminable but are on the order of tens of hundreds of feet. The siltstone and volcanic rocks have structures resembling flowage and primary deformation. However, microscopic examination of several thin sections reveals small-scale fracturing which indicates, at least in part, tectonic deformation. The volcanic material now appears as a felted mass of microcrystalline quartz and sericite. These rocks resemble and are tentatively correlated with the rocks in the Clipper Canyon Group (Ordovician), Toquima Range.

Structural Geology

Three major types of structure are present in the mapped area—high-angle dip-slip faults, thrust faults, and folds. High-angle dip-slip faults both parallel and cut across the range. Those which parallel the range (range faults) are the most recent and are responsible for the existence of the range. The thrust fault separating the allochthonous strata from the autochthonous or parautochthonous strata (the Roberts Mountains thrust) can be viewed only in a few localities, such as south of Toiyabe Peak and in Reeds Canyon. In much of the area the allochthon is downfaulted against the autochthon along the Kingston-Big Creek fault. Both structural sequences have been folded at least twice, and the major folds generally parallel the range. A more detailed analysis of the structural geology is given by Means (1962) and Washburn (1966).

Summary

The autochthonous transitional sequence in the Toiyabe Range consists of sediments deposited in an environment which has not been studied as thoroughly as the eugeosynclinal belt on the west or the miogeosynclinal belt on the east. The sediments are fine grained and may have been deposited far from their source areas in waters of varying depth. Evidence for shallow-water deposition includes archaeocyathid reefs, macluritid gastropods, and fairly large-scale cross-bedding. Indicators of deeper water include horizontally laminated beds of alternating silt and limestone (lower Broad Canyon Formation) and generally unfossiliferous shale and limestone. Limestone and shale of like age are abundantly fossiliferous only 30 mi eastward. This sequence lacks the distinguishing volcanic strata of the eugeosynclinal belt and also lacks the fossiliferous strata of the miogeosynclinal belt. It is much thinner than comparative stratigraphic sections in the mio- and eugeosynclinal belts, and represents a zone of slow deposition in the geosyncline.

The allochthonous sequence on the Roberts Mountains thrust is primarily chert. Volcanic rocks are sparse or absent. The apparent absence of distinctive fossils is puzzling; in time probably more careful searching will produce fossils.

References Cited

Ferguson, H. G., 1924, Geology and ore deposits of the Manhattan district, Nevada: U.S. Geol. Survey Bull. 723, 163 p.

——— and S. H. Cathcart, 1954, Geology of the Round Mountain quadrangle, Nevada: U.S. Geol. Survey Quad. Map Ser. CQ-40.

Hansen, H. J., III, 1960, Geology of the Big Creek area, Toiyabe Range, Lander County, Nevada: unpub. M.A. thesis, Columbia Univ.

Kay, M., and J. P. Crawford, 1964, Paleozoic facies from the miogeosynclinal to the eugeosynclinal belt in thrust slices, central Nevada: Geol. Soc. America Bull., v. 75, p. 425–454.

Lowell, J. D., 1958, Lower and Middle Ordovician stratigraphy in eastern and central Nevada: unpub. Ph. D. dissert., Columbia Univ., 117 p.

Means, W. D., 1962, Structure and stratigraphy in the

central Toiyabe Range, Nevada: California Univ. Pubs. Geol. Sci., v. 42, no. 2, p. 71–110.

Palmer, A. R., 1956, The Cambrian System of the Great Basin in western United States, *in* J. Rodgers, ed., El Sistema Cámbrico, su paleogeografía y el problema de su base, symposium, pt. 2: 20th Internat. Geol. Cong., p. 663–682.

Roberts, R. J., 1964 (1965), Stratigraphy and structure of the Antler Peak quadrangle, Humboldt and Lander Counties, Nevada: U.S. Geol. Survey Prof. Paper 459-A, 91 p.

——— P. E. Hotz, J. Gilluly, and H. G. Ferguson, 1958, Paleozoic rocks of north-central Nevada: Am. Assoc. Petroleum Geologists Bull., v. 42, p. 2813–2857.

Ross, R. J., 1964, Relations of Middle Ordovician time and rock units in Basin Ranges, western United States: Am. Assoc. Petroleum Geologists Bull., v. 48, p. 1526–1554.

Stewart, J. H., 1966, Correlation of Lower Cambrian and some Precambrian strata in the southern Great Basin, California and Nevada: U.S. Geol. Survey Prof. Paper 550-C, p. C66-C72.

——— and E. H. McKee, 1968, Favorable areas for prospecting adjacent to the Roberts thrust, Nevada: U.S. Geol. Survey Circ. 563, 13 p.

——— and A. R. Palmer, 1967, Callaghan window—a newly discovered part of the Roberts thrust, Toiyabe Range, Lander County, Nevada: U.S. Geol. Survey Prof. Paper 575-D, p. D56-D63.

Washburn, R. H., 1966, Structure and Paleozoic stratigraphy of the Toiyabe Range, southern Lander County, Nevada: unpub. doctoral thesis, Columbia Univ., 80 p.