



EXPLANATION

AUTOCHTHONOUS ROCKS

- QTs Sedimentary rocks
Pgu Unit G upper sandstone and conglomerate
Pgl Unit G lower conglomerate
UNCONFORMITY
Pd Unit F - limestone conglomerate
UNCONFORMITY
Pgu Unit E upper red conglomerate and sandstone
Pgl Unit E lower red silt and sand
Pd Unit D - sandy limestone
Pc Unit C - massive limestone
Pb Unit B - pebbly limestone
Pa Unit A - silty arenaceous limestone
Ely Limestone
Mdp Diamond Peak Formation
Mc Chairman Shale
DISCONFORMITY
Mj Joana Limestone
Dp Pilot Shale
Ddg Devils Gate Limestone
Dnb Nevada Formation
Dno Oyo Canyon Sandstone member
Dnbp Beacon Peak Dolomite member
DISCONFORMITY
Sim Lone Mountain Dolomite

ALLOCHTHONOUS AND PARALLOCHTHONOUS ROCKS

- Pi Leonardian rocks
Ow Western assemblage

- Contact—solid where known; dashed where approximately located
Fault—solid where known; dashed where approximately located; dotted where concealed
Thrust fault—southwest on upper plate
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Horizontal beds
Plunge of minor anticline
Plunge of minor syncline
Ancient shoreline
Unconformity or disconformity (in cross sections)

INTRODUCTION

Permian sequences exposed in the central Diamond Mountains are a link between the well-studied formations seen to the east and incomplete Permian sequences further west. Structural relationships seen in the Diamond Mountains help in the understanding of Permian or post-Permian deformation of Paleozoic rocks in the region.
A reconnaissance map of most of the area of the Diamond Springs quadrangle was prepared by Dott (1955). Detailed mapping of part of the eastern side of the range was accomplished by Divers (1957) and by the junior author, Riva (1957). Overall study of the range was carried on by the senior author between 1953 and 1962. Students of the University of Nevada's summer field geology course have mapped key areas in great detail. Conversations with David Brew and Ralph Roberts have been most helpful. John Sales and Abdalaziz Fathi have acted as field assistants.
The senior author is particularly grateful to Mr. and Mrs. Lee Griswold and Mr. and Mrs. Ted Thompson whose generous hospitality has aided greatly in this work. Several grants-in-aid from the Research Committee of the University of Nevada made this study possible.

STRATIGRAPHY

Autochthonous rocks
Lone Mountain Dolomite
The Lone Mountain Dolomite is exposed only in a northward-narrowing triangle extending from Water Canyon to Sheep Canyon. It is a light-gray, coarsely crystalline dolomite. Exposures of the

PRELIMINARY GEOLOGIC MAP AND SECTIONS OF THE DIAMOND SPRINGS QUADRANGLE, NEVADA

By E. R. Larson and John Riva

formation are characteristically ledgy, and weathered surfaces are also light gray.
Nolan and others (1956, p. 38) describe the contact of the formation with the overlying Beacon Peak Dolomite Member of the Nevada Formation as being sharply disconformable in exposures near the Phillipsburg mine immediately south of this quadrangle. The base is not seen. The formation is 200 feet thick in partial exposures on the northern side of Water Canyon.
Formations of Devonian age are exposed in a belt approximately four miles long on the western side of the Diamond Mountains. A complete Devonian sequence is present in the more southeasterly exposures, but some units have been structurally eliminated northward, so that only portions of the Nevada Formation and the Pilot Shale are found at Walters Canyon.
Formations in the quadrangle range from the Lower Devonian Nevada Formation, to the Upper Devonian Devils Gate Limestone and the Pilot Shale.
The presence of *Strigoceras* in the Bay State Dolomite Member of the Nevada Formation indicates its Middle Devonian age, and the presence of *Martinita nevadensis* in the Devils Gate Limestone in adjacent areas indicates its Upper Devonian age (Nolan and others, 1956, p. 46, 50). Fossils from the Pilot Shale at exposures south of the quadrangle in the Packer Basin are also of Devonian age (Nolan and others, 1956, p. 52).

The Nevada Formation consists principally of dolomite with lesser amounts of quartz arenite. Although lithologic differences permit division of the formation into five members in the vicinity of Eureka, only four were recognized in this area: the Beacon Peak Dolomite, the Oyo Canyon Sandstone, the Sentinel Mountain Dolomite, and the Bay State Dolomite.
Nolan and others (1956, p. 42) report about 2,900 feet of the Nevada Formation in the vicinity of the Phillipsburg mine to the south, but structural complexities within the quadrangle prevent accurate measurement of the various members in most places.
Beacon Peak Dolomite Member. This lowest member of the Nevada Formation is between Water Canyon and a point half a mile south of Sheep Canyon. It is principally finely crystalline and light brownish gray. Exposed surfaces of the rock weather to a light gray. At the base of the member is light-gray to bluish-white, well-bedded to cross-bedded orthoquartzite that contains lesser dolomite, quartz arenite and quartz arenaceous dolomite. Osmond (1962, p. 203) gives an excellent description of the unit, which he has identified as the Dolomite Member of the Sevy Formation.
The lower contact of the member is disconformable. The contact with the succeeding Oyo Canyon Sandstone Member is at the base of the latter's thinning quartz arenite.
The member is 940 feet thick at the Phillipsburg mine (Nolan and others, 1956), but only about 150 feet are seen near Sheep Canyon, evidently because of tectonic thinning. Approximately 100 feet of the basal arenaceous beds have been measured at the Phillipsburg mine and near Sheep Canyon.
Oyo Canyon Sandstone Member. The Oyo Canyon Sandstone is easily recognized because of the jagged ridge which it forms in most areas of its outcrop. It is dominantly a brown, weathering light-gray to light olive-gray, heavily bedded to cross-bedded, dolomite-cemented orthoquartzite. Portions of the member are completely siliceous, particularly in mineralized areas. The detrital fragments are medium- to fine-grained, well-rounded, and well-sorted quartz grains.
The lower contact of the Oyo Canyon Sandstone is gradational with the Beacon Peak Dolomite Member. The upper limit was placed at the lowest bed of dark dolomite above the continuous quartzite of the member.
The member is about 450 feet thick throughout much of its area of outcrop.
Sentinel Mountain Dolomite Member. The Sentinel Mountain Dolomite Member, as defined here, is composed principally of dark-gray, fine- to medium-crystalline dolomite, with alternating layers of dark- and light-gray dolomite in the lower part and somewhat coarser dark-gray dolomite in the upper part. The distinctive lower portion, composed of alternating light- and dark-gray dolomite, is the Sentinel Mountain Dolomite as defined by Nolan and others (1956, p. 43). The coarser grained upper dark-gray dolomite portion corresponds to the Woodpecker Limestone Member of Nolan and others (1956, p. 44). The persistence of a traceable marker bed at the base of the overlying Bay State Dolomite Member serves to separate dark-gray dolomite of the revised Sentinel Mountain from the lithologically similar Bay State Member.
The thickness of the revised Sentinel Mountain is approximately 800 feet in exposures on the south side of Water Canyon. It is impossible to establish precisely the position of the Sentinel Mountain-Bay State boundary at its northernmost exposures.
The Bay State Dolomite Member, uppermost member of the Nevada Formation, is principally heavy-bedded, dark-gray medium-crystalline dolomite, with some light-gray beds similar to those in the Sentinel Mountain.
The base of the member is at the base of a unit of medium-gray weathering, medium-dark-gray dolomite, which locally contains pebbles of light-gray weathering dolomite and siltstone (Nolan and others, 1956, p. 43). The basal beds, approximately 95 feet thick in exposures on the south side of Water Canyon, thin northward but can be traced as far as Homestead Canyon. This marker provides the only means of separating the lithologically similar Bay State and Sentinel Mountain Members. The contact of the Bay State and the overlying Devils Gate Formation is gradational.
The Bay State characteristically contains abundant white cylindrical corals of the *Cladopora* type commonly referred to as "spaghetti" rock. Some beds are crowded with *Strigoceras* which can usually be seen only as arcuate sections, though more complete specimens are sometimes found.

The thickness of the member on the south side of Water Canyon is 850 feet. Reliable thicknesses were not measured in more northerly sections because of structural complications in the form of minor folds and faults. The member has been faulted out north of Walters Canyon.
Devils Gate Limestone
The Devils Gate Limestone is composed almost entirely of heavy beds of medium-dark-gray to dark-gray calcite limestone, which generally weather pale yellowish brown. The formation characteristically has a "cherty" outcrop with many small cavities.
The contact of the Devils Gate Limestone and the underlying Bay State Dolomite Member of the Nevada Formation is gradational through a 50-foot zone of interbedded limestone and dolomite. The base of the Devils Gate is defined by the base of the lowest bed of calcite limestone. The contact with the overlying Pilot Shale is gradational through a narrow zone.
The thickness of the formation to the east of the Phillipsburg mine, half a mile south of the quadrangle, is 675 feet (Nolan and others, 1956, p. 48). Reliable thicknesses were not obtained further to the north because of faulting.
Pilot Shale
The Pilot Shale, uppermost formation of the Devonian seen in the quadrangle, is present in a narrow band on the western side of the Diamond Mountains. The formation is composed of a medium-gray to dark-gray or brownish, somewhat calcareous shale below and a darker gray shale above. The rock weathers to a pale reddish or light-yellowish brown, and in some places to a light gray.
The contacts of the formation are generally covered but can be seen east of the Phillipsburg mine, as previously described. The thickness of the formation is about 300 feet.
Collections made from the lower part of the formation indicate a Late Devonian age (Nolan and others, 1956, p. 53). No fossils were found in the upper portion which may be Mississippian in part (Nolan and others, 1956, p. 53).

Permian
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Joana Limestone
The Joana Limestone is, in general, poorly exposed in the quadrangle, and was studied principally from its float and from discontinuous outcrops. The formation is principally a dark-gray to dark-green limestone. Texturally it varies from finely crystalline calcite to a coarsely crystalline calcarenite. Detailed examination of the calcarenite shows it to be composed almost entirely of small crinoid columns.
The Joana Limestone is 1,500 feet thick near USGS's triangulation point Simonson, but has been beveled by an unconformity and is only about 300 feet thick on the western crest of the range near triangulation point YABM Birch. It is absent at Overland Pass, and in the southermost part of the quadrangle.
A 750-foot section of the unit seen one mile northwest of Simonson is mostly of dark-gray, quartz-sand-chert-arenaceous, chert pebbles, and mudstones with some chert pebbles conglomerate up to 1 foot thick. Dusky red-weathering siltstone occurs on many of the bedding planes. The unit is thinner near the eastern edge of the range and the clastic content of the rock is finer grained and less abundant.
Unit B contains an abundant fusulinid fauna which includes *Parafusulina* sp., *Schwagerina* cf. *S. gumbellii* pseudobipolysyllis, suggesting a middle Leonardian age.
Unit C
Unit C is a massive- to thin-bedded medium- to dark-gray limestone with some grayish-red layers. At many localities the weathered surface is pale grayish red to pale yellowish brown because of contained silty material. The crystalline texture ranges from very fine to coarse, the latter having many crinoid columns and fusulines.

Unit D
Unit D is exposed almost exclusively on the eastern side of the Diamond Mountains. The unit is 1,500 feet thick near USGS's triangulation point Simonson, but has been beveled by an unconformity and is only about 300 feet thick on the western crest of the range near triangulation point YABM Birch. It is absent at Overland Pass, and in the southermost part of the quadrangle.
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Unit E
Unit E is an easily seen sequence of red-weathering, light-brown and dusky-red calcareous quartz arenite and siltstone which grades upward into a medium- to dusky-red-weathering sequence of dusky-red quartz arenite, chert coarse arenite, and chert pebble conglomerate.
The unit is present only on the eastern edge of the Diamond range between Spring Canyon and Big Canyon.
Unit E is 850 feet thick in an incomplete section at Little Canyon, 700 feet of which are the "red bed" portion. The similarity of the unit to the Newark Canyon Formation at Southgate is about 1,350 feet thick. South of Big Canyon the unit is only about 150 feet thick and includes 100 feet of the "red bed" portion.
As Unit E is traced northward from Little Canyon it is seen to have been beveled by a surface of unconformity, so that only the lower portion of the sequence is present north of Horse Canyon. It, too, is beveled by the basal beds of Unit F, half a mile further north.
The gradational contact with Unit D suggests that it is of late Leonardian age.
Unit F
Unit F is exposed only on the easternmost border of the Diamond Mountains between Big Canyon and Canon Canyon.
The major portion of the unit is composed of pebbles and small cobbles of medium-gray, weathering dark-gray, limestone and pebbles of light-gray chert, all in a calcite-cemented chert and quartz-arenite matrix. The chert clasts are subangular to rounded, the limestone fragments are plate-like and suggest an intraformational conglomerate. Thin beds of medium-dark-gray and light-pinkish-gray limestone and fine quartz arenite occur in the unit.
The basal beds of Unit F are 10 to 40 feet of siliceous-cemented chert pebble conglomerate overlain by approximately 200 feet of laminated calcareous sandstone, and sandy, dark-gray limestone. The total thickness of Unit F is not known but is estimated to be more than 300 feet.
Unit F is unconformable on older units, but the basal conglomerate is subparallel to conglomerates of the upper portion of Unit E on the south side of Big Canyon, and lies on Unit D one mile north of Big Canyon.
Bisell (1962, p. 110) reports Leonardian and lower Warden fusulines in a limestone layer in the Newark Canyon Formation at Southgate, 32 miles to the south of Big Canyon, thus changing the age assignment of this formation from Cretaceous (Nolan and others, 1956, p. 49) to Permian. The Newark Canyon Formation at Southgate is chert and quartz pebble and cobble conglomerate below, and chert pebble-bearing limestone conglomerate above. The latter is limestone conglomerate lithologically like Unit F.
If Unit F is equivalent to the fusuline-bearing beds at Southgate, it is of late Leonardian or lower Warden age.
Unit G
Unit G, the youngest of the Permian units, forms the prominent crest of the Diamond Mountains throughout most of the quadrangle. The lower beds of the unit are a reddish-brown to gray-weathering conglomerate of light-gray chert and chert, with lesser gray quartzite and some green chert. Unit G lies unconformably on Units A through D, at places with marked angularity. The lower conglomerate is about 1,500 feet thick near YABM Birch but is only 200 feet in width one mile to the east and only 10 feet thick one mile east of that. The thickness of the conglomerate also varies along its strike, being 200 feet at Overland Pass but 1,000 feet thick in exposures to the north. It is completely absent near the northern edge of the quadrangle.
The upper beds of Unit G are yellowish-brown quartz arenites with lesser chert conglomerates. Overlying these are dark-red quartz arenite and mudstones with some chert pebble conglomerate. The thickness of Unit G is more than 2,500 feet thick in its northern exposures.
Unit G is correlated with the third member of the Garden Valley Formation (Nolan and others, 1956, p. 47) because of lithic similarity and stratigraphic position.
Steele (1960, p. 112) dates the third member of the Garden Valley as Upper Guadalupian because of regional stratigraphic relationships. This age designation is accepted for Unit G.

CENOZOIC DEPOSITS
Alluvial fans of probable Tertiary and Quaternary age are seen at the base of the Diamond Mountains. The earlier fans have been notched by the shore lines of separate lakes which earlier lay in Diamond Valley and in Newark Valley to the east of this quadrangle. The central portion of the valley is covered by lake sediments, playa clays, and alluvial deposits.
The presence of western assemblage rocks at Walters Canyon was first suggested by Roberts and others (1958, fig. 4, p. 2823). Dark- and light-gray quartzites and argillites of the western assemblage are seen in klippen and fault slices of several places along the western base of the Diamond Mountains. These exotic rocks are tentatively assigned to the Ordovician because of their resemblance to certain beds within the Vinini Formation, and to exotic Ordovician? rocks seen on the western side of Diamond Valley.
1. In a small klippe at Thompson's Ranch the western facies rocks are lying on the Permian. The allochthonous rocks are dark calcareous orthoquartzite, with some dark-gray completely silicified rock having a breccia of platy fossiliferous fragments.
2. Light- and dark-gray quartzites and some dark limestones form the main portion of small klippen on the Sentinel Mountain Dolomite at the mouth of Walters Canyon. Lesser amounts of red-weathering, shered phyllitic rock are under the ore on the mine and at a mined area half a mile to the south.
3. In a fault slice extending from Walters Canyon to Sheep Canyon the western facies rocks lie between the Pilot Shale and the Devils Gate Limestone and Bay State Dolomite. The most westerly lower? beds are fine-grained, reddish-weathering quartz arenite. Succeeding beds are reddish-weathering dolomite and light- to dark-gray quartzite of well-rounded grains. The youngest beds are beddy-shaded dark-gray quartzite.

STRUCTURE
The Diamond Mountains are bordered on the east and the west by north-trending faults typical of the Basin and Range province. Evidence that Diamond Valley had dropped, relative to the range, is seen in the presence of thick accumulations of Cenozoic sediments in the valley.
The main portion of the range is a northward-trending asymmetric syncline, the western limb of which is vertical or slightly overthrust. Smaller angular asymmetric anticlines and synclines are present on both flanks of the range (see sections).
Minor structural complications were introduced by diastrophic folding of the Diamond Peak Formation and Ely Limestone, principally on the western side of the range. Extreme diastrophic folding has affected the Ely Limestone on the south side of Walters Canyon. Beds which dip 45 degrees eastward can be followed continuously to points where they are overturned and dip 35 degrees or less to the west. No fault marks this transition. The diastrophic folding was mistaken for reverse faulting by Dott (1955, fig. 15) but no fault was shown.
Southeast of Judd Canyon, at hill 9215, conglomerates of Unit G are about 1,500 feet thick, but north and south of that point they dip 40°-50° to the east. This steepening is due to a reverse fault which forced an asymmetric anticline of the Ely Limestone and the Diamond Peak Formation against the Permian formations (see sec. A-A'), forcing Unit G upward and eastward.
The reverse fault and the oblique fault which cut the crest of the range north of Judd Canyon, outline a trap door fault block, the absolute movement of which was upward (Larson, 1959), and which was rotated around a northeast-trending horizontal axis slightly east of the present range crest. Movement of the reverse fault block and the trap door block were synchronous.
A large reverse fault which can be traced almost continuously for 25 miles along the western base of the range, places the Leonardian beds against older rocks. Leonardian rocks are in contact with either the Diamond Peak Formation or the Chairman Shale in the northern part of the quadrangle, and are in contact with the Lone Mountain Dolomite at Walters Canyon. Extreme elongation of continued fusulines and chert pebbles indicates the compressive nature of the fault. As stated, the Permian beds are the overturned limb of a fold.
Klippen of western facies rocks seen both at Thompson's Ranch and Walters Canyon, are remnants of a former tilted block. Small klippen of the same thrust sheet are present south of Monroe Canyon, and similar rocks are present in a fault-bounded silver between Walters and Sheep Canyons.
The silver is a segment of a thrust sheet of western facies rocks which has been cut off by a rotational reverse fault present between Walters and Monroe Canyons. The latter fault eliminates the Devils Gate Limestone and brings the Bay State Dolomite Member against the overthrust western facies rocks (see sec. F-F'), which had already been in contact with the Pilot Shale.
The progressive elimination of Devonian units northward from Monroe to Walters Canyon, and the abrupt structural differences on opposite sides of that canyon, are related phenomena. The Devonian units were eliminated by a rotational reverse fault (mentioned above), the displacement of which increased northward. The axis of rotation was evidently in the vicinity of Walters Canyon. Movement took place on several intersecting planes, resulting in an imbricate structure.
The structural differences seen on the opposite side of Walters Canyon are interpreted as the result of rotational reverse movement on a vertical fault. This feature allowed an anticline to form north of the canyon while beds to the south were being folded as a part of the general syncline of the Diamond Mountains.
The Permian formations, the Ely Limestone, and the Diamond Peak formations are cut by an easterly directed vertical fault at the head of Thremite Canyon. Detailed study shows that this fault movement has been oblique, the northern block having moved eastward approximately 700 feet and upward approximately 3,500 feet. The fault displaces neither the lower portion of the Diamond Peak Formation on the western side of the range nor the older Permian beds on the eastern base.
The faulting was confined principally to the more brittle Permian conglomerate in the core of the syncline at the present range crest and in the asymmetric anticline to the west. Similar east-trending faults have displaced the rocks of the upper portion of the range both north and south of Thremite Canyon.

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