Upper Precambrian and Lower Cambrian Strata in the Southern Great Basin California and Nevada

By JOHN H. STEWART

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Stratigraphy and origin of the thick upper Precambrian and Lower Cambrian detrital rocks that constitute the initial deposits of the Cordilleran geosyncline

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UPPER PRECAMBRIAN AND LOWER CAMBRIAN STRATA IN THE SOUTHERN GREAT BASIN, CALIFORNIA AND NEVADA

By John H. Stewart

ABSTRACT

The upper Precambrian and Lower Cambrian strata in the southern Great Basin consists of widespread units of quartzite, conglomeratic quartzite, siltstone, shaly siltstone, limestone, and dolomite. They are the initial deposits in the Cordilleran geosyncline and form a wedge of sediment that thickens from less than 400 feet in the eastern part of the region to about 21,000 feet in areas 175 miles to the northwest. They are generally finer grained and contain more limestone and dolomite to the northwest.

These strata lie with angular unconformity on strongly folded medium- to high-grade metamorphic rocks that are dated as 1.1–1.8 billion years; they are conformably overlain by Middle Cambrian and younger strata composed predominantly of carbonate.

The stratigraphy is described by regions (eastern, central, and western), each of which has a separate nomenclature. The eastern region includes easternmost Nevada and adjacent parts of California; the central region includes the Spring Mountains in Nevada, Death Valley in California, and adjacent areas; and the western region includes the White and Inyo Mountains in California, Esmeralda County, Nev., and adjacent areas. The nomenclatural differences reflect corresponding differences in the lithologic character of the strata from region to region. A formation mappable in one region is not mappable, except locally, in another region, even though physically correlative strata are recognized. Changes in nomenclature are thus a practical necessity as well as stratigraphically significant.

In the eastern region, a thin sandstone, quartzite, and conglomerate unit, the Tapeats Sandstone, overlies lower Precambrian metamorphic rocks. Here the Tapeats, along with some overlying shale and limestone, are Early Cambrian in age, although locally the lowermost part of the Tapeats could be Precambrian. The Tapeats is generally only a few hundred feet thick and represents a thin shelf deposit east of the main upper Precambrian and Lower Cambrian miogeosynclinal belt.

The upper Precambrian and Lower Cambrian strata in the central region consist of a westward-thickening wedge of dominantly clastic rocks assigned, in ascending order, to the Pahrump Group, Noonday Dolomite, Johnnie Formation, and Stirling Quartzite of late Precambrian age; the Wood Canyon Formation of late Precambrian and Early Cambrian age; the Zabriskie Quartzite of Early Cambrian age; and the Carrara Formation of Early and Middle Cambrian age.

The Pahrump Group (upper Precambrian) crops out in the Death Valley area and is the oldest sequence of strata in the southern Great Basin that rest on lower Precambrian gneiss and schist. No correlative strata have been recognized elsewhere in the southern Great Basin. The Pahrump Group consists of shale, siltstone, quartzite, conglomeratic quartzite, conglomeratic mudstone, limestone, dolomite, and chert and is a maximum of 7,000–8,000 feet thick. Units in the upper part of this group are considered by some geologists to be tillites and by other geologists to be turbidites.

The Noonday Dolomite (upper Precambrian) unconformably overlies the Pahrump Group and crops out in Death Valley and adjacent areas. The Noonday consists mostly of algal and sandy dolomite, but locally it contains thick members of silty limestone and shale. The formation is generally about 1,500 feet thick or slightly less.

The conformably overlying Johnnie Formation (upper Precambrian) has a wide distribution in the central region and is composed of siltstone, quartzite, carbonate, and scarce amounts of conglomerate. It thickens to 5,000 feet from 0 feet in the eastern part of the region. Six members of the Johnnie Formation are recognized in the southern Death Valley-Kingston Range area, but only the uppermost of these, the Rainstorm Member, occurs elsewhere. Strata that are possibly tuffaceous have been reported in the Johnnie, although the chemical composition of these strata does not resemble that of unaltered igneous rocks.

The conformably overlying Stirling Quartzite (upper Precambrian) is recognized in about 15,000 square miles in the central region of the southern Great Basin. It thickens from 0 feet in the eastern part of the region to over 5,000 feet in the Death Valley area. It is divided into five members and is composed of medium- to coarse-grained quartzite and minor amounts of siltstone and carbonate. Studies of the direction of dip of cross-strata show that current directions are westerly in the Stirling.

The Wood Canyon Formation (upper Precambrian and Lower Cambrian) conformably overlies the Stirling Quartzite and covers a large part of the central region of the southern Great Basin. It thickens from 0 feet near the eastern edge of the central region to nearly 4,000 feet in the western part. Correlative strata are over 6,000 feet thick in the western region of the southern Great Basin. The upper and lower members of the Wood Canyon are composed of siltstone, fine-grained quartzite that is locally arkosic, and minor amounts of carbonate. A middle member is composed of medium- to coarse-grained, locally conglomeratic, quartzite that is commonly feldspathic. Current directions in the middle member are westerly.

Trilobites, brachiopods, pelmatozoan debris, *Hyolithes,* and, in a few places, archeocyathids occur in the upper part of the upper member, the lowest occurrence of metazoan fossils, other than trace fossils such as tracks and trails, in rocks of the central region.

The Zabriskie Quartzite (Lower Cambrian), which conformably overlies the Wood Canyon Formation, is widely distributed in the central region and consists of a pure (over 97 percent SiO_2) medium- to coarse-grained quartzite. It increases in thickness from 0 feet near the eastern edge of the central region to over 1,000 feet in the western part. Correlative strata are over 2,000 feet thick in the western region of the southern Great Basin.

The Carrara Formation (Lower and Middle Cambrian) conformably overlies the Zabriskie Quartzite in the central region and consists largely of siltstone and carbonate; the lower part contains minor amounts of quartzite. It is generally about 1,300–2,000 feet thick.

The upper Precambrian and Lower Cambrian strata in the western region of the southern Great Basin are thicker, finer textured, and more carbonate-rich than correlative strata in the central region. They consist, in ascending order, of the Wyman Formation, Reed Dolomite, and Deep Spring Formation of late Precambrian age; the Campito Formation of late Precambrian and Early Cambrian age; and the Poleta Formation, Harkless Formation, Saline Valley Formation, and Mule Spring Limestone of Early Cambrian age.

The Wyman Formation (upper Precambrian) consists of phyllitic siltstone, phyllitic silty claystone, and minor amounts of carbonate; it is over 9,000 feet thick in an incomplete section in the Inyo Mountains. The Wyman may be laterally equivalent to the Johnnie Formation and the lower part of the Stirling Quartzite of the central region, but this correlation is uncertain because of widely spaced outcrops and changes in facies.

The Reed Dolomite (upper Precambrian) overlies the Wyman; the contact between these two formations is considered to be unconformable by some geologists, but is said to be conformable by others. The Reed is about 1,500–1,700 feet thick and consists mostly of light-colored medium- to coarsely crystalline dolomite; the middle part contains a wedge of clastic material. The Reed is considered to be laterally equivalent to dolomite and quartzite in the upper part of the Stirling Quartzite of the central region.

The conformably overlying Deep Spring Formation (upper Precambrian) of the western region consists of a heterogeneous sequence, about 1,100–1,6000 feet thick, of siltstone, sandstone, limy or dolomitic sandstone, quartzite, sandy limestone and dolomite, limestone, and dolomite. It becomes generally more carbonate-rich to the north and northwest. The Deep Spring Formation is a carbonate-rich lateral equivalent of the lower part of the Wood Canyon Formation of the central region.

The conformably overlying Campito Formation (upper Precambrian and Lower Cambrian) of the western region is about 3,500 feet thick and is composed of very fine to fine-grained quartzite and minor amounts of siltstone. Trilobites occur near the middle of the Campito, the lowest occurrence of these fossils in the western region. The Campito is correlated on the basis of lithologic and faunal evidence with the middle part of the Wood Canyon Formation of the central region.

The conformably overlying Poleta Formation (Lower Cambrian) of the western region is 850–1,900 feet thick. It consists of limestone in the lower and upper parts, and of siltstone, quartzite, and some limestone in the middle. Archeocyathids and trilobites are abundant in the Poleta and help to establish a correlation with the upper part of the Wood Canyon Formation of the central region.

The conformably overlying Harkless Formation (Lower Cambrian) is about 2,000–3,600 feet thick and consists of siltstone and scarce to abundant layers of fine- to medium-grained quartzite (tongues of the Zabriskie Quartzite of the central region). It contains archeocyathid-bearing limestone layers in the lower part. The Harkless is a thick fine-textured lateral equivalent of the uppermost part of the Wood Canyon Formation and the lower and middle parts of the overlying Zabriskie Quartzite of the central region.

The conformably overlying Saline Valley Formation (Lower Cambrian) is recognized only in the White and Inyo Mountains and in the Last Chance Range area, although correlative strata occur locally in Esmeralda County, Nev., where they are included in the Harkless Formation. The Saline Valley Formation is a lithologicaly heterogeneous and laterally variable unit about 800 feet thick and is composed of layers of fine- to medium-grained quartzite (tongues of the Zabriskie Quartzite of the central region), sandy limestone, limestone, and shale. The formation contains a distinctive and varied trilobite fauna. The lower and upper parts of the formation are laterally equivalent to the upper part of the Zabriskie Quartzite and the lowermost part of the Carrara Formation of the central region, respectively.

The Mule Spring Limestone (Lower Cambrian) of the central region is about 500–1,000 feet thick and consists of limestone containing abundant concretionary algal structures (*Girvanella*). Separate limestone units near the top of the lower third of the Carrara Formation of the central region coalesce northwestward to form the Mule Spring Limestone.

Most of the upper Precambrian and Lower Cambrian strata in the southern Great Basin have the same general geometric and lithologic characteristics and possibly the same general time-stratigraphic characteristics: (1) they extend for large distances in the direction of sedimentary strike, which is to the north or northeast, without change in facies or thickness; (2) they thicken and become finer grained and carbonate-rich in the direction of sediment transport, which is westward or northwestward; and (3) they appear to be virtually time conformable, rather than time transgressive. These characteristics indicate a uniform tectonic and sedimentary environment during much of late Precambrian and Early Cambrian time.

The upper Precambrian and Lower Cambrian strata probably accumulated on a marine shelf, as indicated by their widespread uniformity of composition, thickness, and stratification. The occurrence of a shallow-water fauna of trilobites, brachiopods, and archeocyathids in the upper half supports the idea of a shelf environment. The generally westward current directions, indicated by cross-strata studies, and the composition of the sediments indicate a source to the east in a cratonic lower Precambrian terrane composed of metasedimentary gneiss, schist, quartzite, marble, and associated granitic and pegmatitic bodies. The sediments were deposited by strong marine currents, apparently of tidal origin.

INTRODUCTION

Upper Precambrian and Lower Cambrian strata are widespread in the southern Great Basin and present a rare opportunity to study the regional sedimentary characteristics of a thick detrital sequence. These strata are the initial deposits of the Cordilleran geosyncline, a dominant early tectonic feature of western North America. The region is one of the few in the world that contains a thick sequence of fossiliferous strata of late Precambrian and Early Cambrian age, an important time of life evolution.

This report describes the regional correlation of these strata as well as their sedimentary, petrographic, and chemical characteristics, fossil content, and origin. The study was an outgrowth of geologic mapping by the writer and J. P. Albers in the central part of western Nevada during 1960–62 and was continued as a special study elsewhere in the region during 1962–65.

The study has benefited greatly from discussions with many geologists, including Harley Barnes, H. R. Cornwall, F. J. Kleinhampl, J. F. McAllister, E. H. McKee, A. R. Palmer, M. V. Reynolds, all of the U.S. Geological Survey; C. A. Nelson, of the University of California, Los Angeles; L. A. Wright, of Pennsylvania State University; and B. W. Troxel, of the California Division of Mines and Geology. Several of these geologists kindly supplied unpublished information. D. B. Tatlock provided invaluable assistance in interpreting chemical and X-ray data. My wife, Sarah D. Stewart, provided continual encouragement and helped me measure most of the stratigraphic sections.

METHODS OF STUDY

The methods used in studying the upper Precambrian and Lower Cambrian strata were diverse and included geologic mapping, measuring stratigraphic sections, studies of the direction of dip of cross-strata, studies of the petrographic and chemical characteristics of the rocks, and compilation of published and unpublished data.

Correlations are based largely on the recognition from one area to another of lithologically similar, and thus possibly correlative, strata. In parts of the southern Great Basin, individual units can be traced or mapped continuously on exposures, but most commonly outcrops are scattered and correlations are based entirely on the lithologic similarity of units from area to area. Most of the stratigraphic units studied are distinctive and easily recognizable. Correlations from one area to another are supported by identical, or nearly identical, successions of lithologic units. Fossil information also helps to establish correlations, particularly in the Lower Cambrian part of the sequence, where several trilobite faunal zones are recognized. Less impressive fossil occurrences, however, may even be useful; for example, the lowest occurrence of trace fossils such as tracks and trails may be in rocks that are in approximately the same stratigraphic position throughout the southern Great Basin.

The correlations presented in this paper seem to be well established in general, and many have been recognized previously by other geologists. The similarity of the units from place to place is so remarkable and the changes in facies are generally so gradual and systematic that the writer feels confident, except where otherwise noted, of the correlations presented.

Measurements of the direction of dip of cross-strata were made at many localities in several different formations in the region. About 30–50 individual measurements were taken at a locality, and only one measurement was taken in any one set of cross-strata. The cross-strata are difficult to see in many areas because of the dense quartzitic character of the rock, and a reading was taken only where the orientation of a cross-stratum could be determined with at least fair accuracy. The component of dip imposed by structural tilt about a horizontal axis was removed from the readings with the help of a computer, so the stated resultant dip reflects the original depositional orientation and not that due to later structural deformation. In some places, however, the strata may have been rotated structurally about a vertical axis. Such deformation is difficult or impossible to demonstrate, and no attempt has been made to remove the effects of this type of movement from the readings.

STRUCTURAL SETTING

The southern Great Basin is a structurally complex area characterized by many low- and high-angle faults and tight folds. Measurements of stratigraphic thickness in much of the area is subject to error because of the possibility of crossing concealed or obcure faults or folds. Even detailed mapping in some places may not fully define structural features that affect the measurement of stratigraphic thickness. A

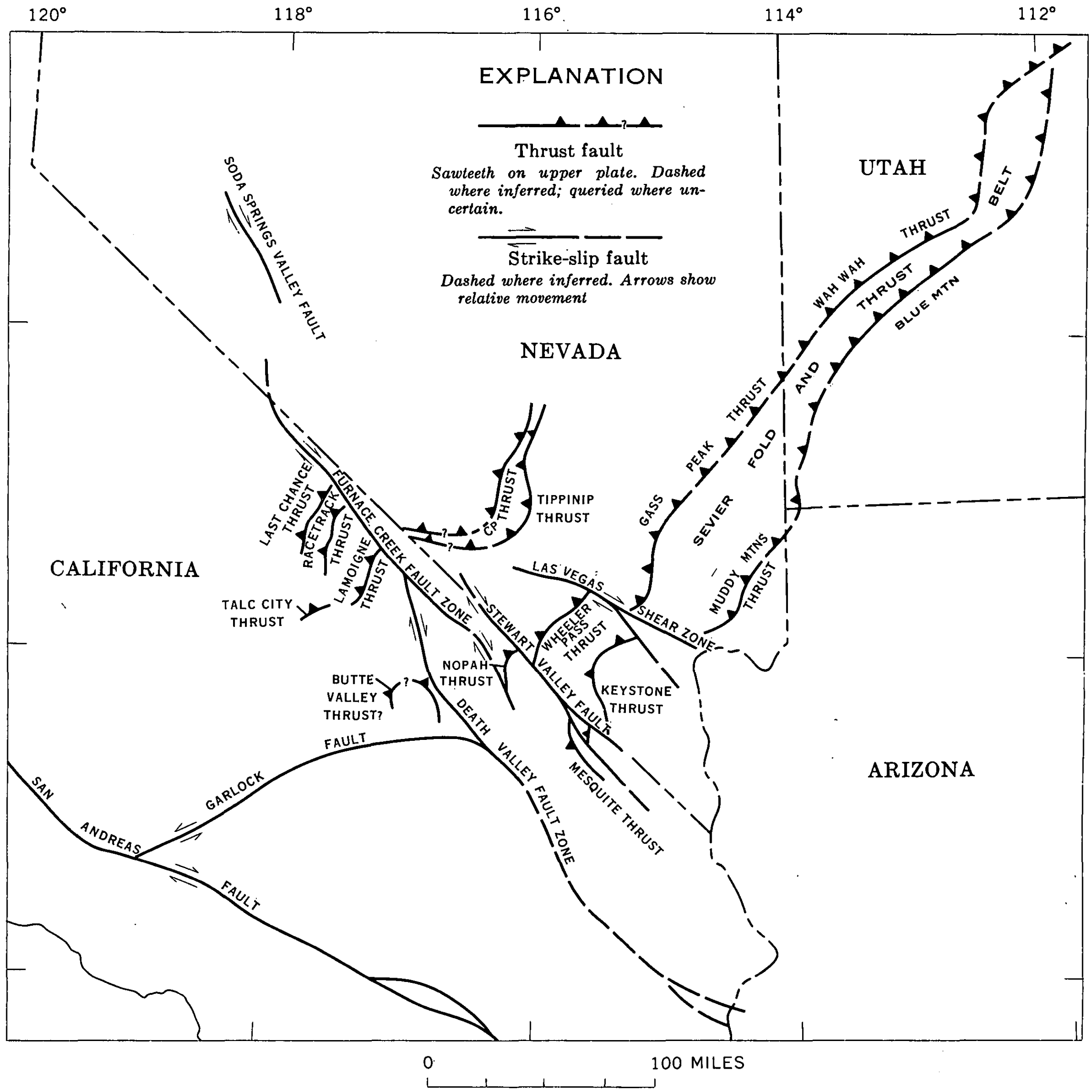

FIGURE 1.—Major thrust and strike-slip faults in the southern Great Basin and adjacent area (modified from F. G. Poole and others, 1967, fig. 1).

careful appraisal, nonetheless, including mapping in some areas, was always made of local structural features. In some areas, the possibility of unknown faults was suggested by unusual thicknesses of the stratigraphic units, and checking in these areas commonly indicated faults that had been missed previously or that were thought to be structurally unimportant.

The greatest problems caused by structural complexities, however, are not related to uncertainties of measurement, but to large displacements along Mesozoic and Tertiary thrust faults and strike-slip faults that have disrupted original regional sedimentary relationships. Thrust faults are numerous in the southern Great Basin (fig. 1). Their surface traces are generally to the northeast or north, and the upper plate strata have been transported to the east (Hewett, 1956, p. 1; Hall and MacKevett, 1962, p. 42; Hall and Stephens, 1963, p. 20; Burchfiel, 1965, fig. 4; Stewart and others, 1966). The amount of displacement on these thrusts is difficult to determine, but a minimum of 20 miles on the Last Chance thrust has been estimated (Stewart and others, 1966) and 35 miles on the CP thrust has been inferred (Barnes and others, 1966). Displacement along the Mesquite thrust fault has also probably been large, for along this fault are juxtaposed upper Precambrian and Lower Cambrian strata of markedly contrasting thickness (Hewett, 1956, p. 28, figs. 4, 6). The thrust faulting in the southern Great Basin is probably in part a lateral continuation of the thrusting in the Sevier belt in easternmost Nevada and western Utah, where a minimum of 40 miles of displacement has been suggested by Armstrong (1963, p. 110). The total east-west crustal shortening caused by thrusting in the southern Great Basin may therefore be 40 miles and could be much more than this.

Offset on strike-slip faults may also be large—about 30 miles on the Las Vegas shear zone and 50 miles on the Death Valley–Furnace Creek fault zone (Longwell, 1960; Ross and Longwell, 1964, p. C–88; Burchfiel, 1965, p. 186; Stewart, 1967; Stewart and others, 1968). Considerable displacement in the southern Great Basin may also have taken place on gigantic structural bends or oroflexural folds (Albers, 1967; Stewart, 1967).

In this report, major thrust and strike-slip faults are indicated in some figures, but not in others. No structural features are shown on the correlation diagrams, which are intended strictly as illustrations of correlation. On the isopach maps, only those faults that obviously disrupt thickness trends are shown; these faults are the Las Vegas shear zone, the Furnace Creek fault zone, the Death Valley fault zone, and the Mesquite thrust fault. Several other thrust faults are fundamentally just as important as the Mesquite, but upper Precambrian and Lower Cambrian thickness and facies trends cannot be shown, with available information, to be disrupted by them. On the palinspastic diagrams, the writer would ideally like to present data that are corrected for crustal shortening due to thrust faulting as well as for offset due to strike-slip faulting. Unfortunately, the amount of displacement on the thrust faults is poorly understood, and an attempt to indicate minimum or absolute amounts of displacements on these faults might produce more problems than it would solve. For this reason, the palinspastic maps (actually partial palinspastic maps) compensate only for strike-slip faulting. As the direction of thrusting is mostly at right angles to sedimentary trends and isopach lines, thrust faulting has the effect of exaggerating the rate of change in an east-west direction—the direction of crustal shortening.

PREVIOUS WORK

The earliest geologic work on strata now recognized as Precambrian and Cambrian in the southern Great Basin was by Gilbert (1875), Turner (1902), Spurr (1903), and Ball (1907). These geologists focused attention on the presence of these strata in the region.

In 1908, Walcott (p. 185–189) described a Lower Cambrian section in Esmeralda County, Nev., and one near Waucoba Spring in the Inyo Mountains, Calif. Later, Walcott (1912, p. 305–306) proposed the name Waucoban Series, named for Waucoba Spring, for strata of Early Cambrian age, and this name is still in use.

The first systematic and detailed study of these strata was by Edwin Kirk (in Knopf, 1918). He described the Precambrian and Cambrian stratigraphic section in the Inyo Mountains in the western part of the southern Great Basin and named the Reed Dolomite, Deep Spring Formation, and Campito Formation. These formations are presently recognized largely as Kirk described them, and the same names are used.

In the central part of the southern Great Basin, southeast of the area studied by Kirk, Nolan (1924, 1929) mapped in reconnaissance the Precambrian-Cambrian succession in the western part of the Spring Mountains. He named the Johnnie Formation, Stirling Quartzite, and Wood Canyon Formation, and these names are still in use. Hazzard (1937a) extended the use of these names to the southern part of the Nopah Range and described and named the Noonday Dolomite and the Zabriskie Quartzite. The Noonday lies below the Johnnie Formation, and the Zabriskie, as presently recognized, is above the Wood Canyon Formation.

Another important stratigraphic study in the 1930's was by Murphy (1932) in the Panamint Range. He named and described many units in strata now regarded as upper Precambrian and Lower Cambrian, and several of his names are still commonly used.

In the 1940's, Hewett (1940) described and named the Pahrump Series and its three formations, Noble (1941)

TABLE 1.—*Upper Precambrian and Lower Cambrian strata in the southern Great Basin*

Age	Western region	Central region		Eastern region
Middle Cambrian	Monola Formation	Carrara Formation		Bright Angel Shale
Early Cambrian	Mule Spring Limestone			
	Saline Valley Formation	Zabriskie Quartzite		Tapeats Sandstone
	Harkless Formation			
	Poleta Formation	Wood Canyon Formation		
	Campito Formation			
Late Precambrian	Deep Spring Formation			Hiatus
	Reed Dolomite	Stirling Quartzite		
	Wyman Formation (base not exposed)	Johnnie Formation		
		Noonday Dolomite		
		Pahrump Group	Kingston Peak Formation	
			Beck Spring Dolomite	
			Crystal Spring Formation	
Older Precambrian		Gneiss and schist		Gneiss and schist

recognized the wide extent of many of the Precambrian and Cambrian units in the Death Valley area, and Wheeler (1943, 1948) proposed correlations of the Precambrian and Cambrian rocks over a large area of the Great Basin.

Beginning in the 1950's, the number of published descriptions of the Precambrian and Cambrian strata increased greatly. These papers are too numerous to list completely, but some of the important ones are as follows: Hazzard (1954) and Hewett (1956) wrote about the Mojave Desert, Calif.; Wright (1952, 1954), Johnson (1957), Hunt and Mabey (1966), Wright and Troxel (1966, 1967) and Troxel (1967) about the southern part of the Death Valley area, California; Longwell, Pampeyan, Bowyer, and Roberts (1965) about Clark County, Nev.; Burchfiel (1964) and Barnes and Christiansen (1967) about the area in and near the Nevada Test Site in Nevada; Merriam (1964) at Pioche, Nev.; Stewart and Barnes (1966) about the Desert Range, Nev.; Cornwall and Kleinhampl (1964) about the area on Bare Mountain, Nev.; Stewart (1965) about the Last Chance Range, Calif.; Nelson (1962) about the White and Inyo Mountains, Calif.; and Albers and Stewart (1962), McKee and Moiola (1962), and McKee (1962, 1968) about the area in and near Esmeralda County, Nev. Some of the results of the present study have already been published (Stewart, 1966).

STRATIGRAPHY

The upper Precambrian and Lower Cambrian strata in the southern Great Basin consist of widespread units of quartzite, conglomeratic quartzite, siltstone, shaly siltstone, limestone, and dolomite. They are the initial deposits in the Cordilleran geosyncline and form a wedge of sediment that thickens from less than 400 feet in the eastern part of the region to about 21,000 feet 175 miles to the northwest. They are generally finer grained and contain more limestone and dolomite to the northwest.

The stratigraphy is described by regions (eastern, central, and western; table 1 and pl. 1). Each region has a separate stratigraphic nomenclature that reflects differences in the lithologic character of the strata there in relation to the lithologic character of equivalent strata in the other regions. A formation that is mappable in one region is not mappable, except locally, in another region, even though correlative strata are recognized. The changes in stratigraphic nomenclature across the southern Great Basin are thus of practical necessity as well as of stratigraphic significance. Nonetheless, lateral lithologic changes in the upper Precambrian and Lower Cambrian strata occur gradually, and the boundaries between the nomenclatural regions do not mark conspicuous lithologic breaks.

In the eastern region, a thin sandstone, quartzite, and conglomerate unit, the Tapeats Sandstone, rests unconformably on lower Precambrian metamorphic rocks. The Tapeats and a thin overlying unit of shale, siltstone, and limestone are of Early Cambrian age, although locally the lowermost part of the Tapeats could be Precambrian. In the central region, the upper Precambrian and Lower Cambrian strata consist of a westward-thickening wedge of fine- to coarse-grained quartzite, siltstone, and minor amounts of carbonate rock; the strata in this wedge are assigned to nine formations (table 1). In the western region, strata that are laterally equivalent to those of the central region are thicker, finer textured, and more carbonate rich. They consist of siltstone, limestone, dolomite, and very fine to fine-grained quartzite and are assigned to eight formations (table 1).

In west-central, central, and east-central Nevada, strata that are probably equivalent to the upper Precambrian and Lower Cambrian of the southern Great Basin are recognized, although exact correlations have not been made. In west-central Nevada (pl. 1), the name Gold Hill Formation (Ferguson, 1924; Ferguson and Cathcart, 1954) is used for quartzite and siltstone that are at least in part of Early Cambrian age. In central and east-central Nevada and in western Utah, the Prospect Mountain Quartzite (Hague, 1883, p. 254; Nolan and others, 1956, p. 6–7) of Early Cambrian age and the Pioche Shale of Early and Middle Cambrian age are recognized. In east-central Nevada, the McCoy Creek Group of Misch and Hazzard (1962) and the overlying Prospect Mountain Quartzite and Pioche Shale are recognized (pl. 1).

The upper Precambrian and Lower Cambrian strata lie with prominent angular unconformity on strongly folded medium- to high-grade metamorphic rocks of older Precambrian age. Metasedimentary gneiss, schist, marble, and associated granitic and pegmatitic bodies constitute the main mass of the older Precambrian rocks. Dating of these rocks by uranium-lead, potassium-argon, and rubidium-strontium methods gives an age of 1.1–1.8 billion years (Lanphere and Wasserburg, 1963; Volborth, 1962; Armstrong, 1963; Wasserburg and others, 1969; Lanphere and others, 1963).

The Lower Cambrian strata are conformably overlain by siltstone and carbonate strata of Middle Cambrian age. Although the lowermost Middle Cambrian strata are commonly siltstone and shale, the remainder of the lower Paleozoic strata in the southern Great Basin are predominantly carbonate rocks; so they contrast strongly with the underlying detrital strata of Early Cambrian and late Precambrian age.

The age designations used in this report are in accord with the practice of assigning to the Cambrian all rocks that contain olenellid trilobites or archeocyathids, or the demonstrated temporal equivalents of these rocks, and assigning to the Precambrian all lower rocks. Such usage is essentially that proposed by Wheeler (1947). Cloud and Nelson (1966), however, placed the contact somewhere lower because some trace fossils such as tracks and trails occurring below the lowest olenellid-archeocyathid faunas probably were produced by arthropods, perhaps trilobites; in addition, they noted that a mollusklike form even lower than the trace fossils is at least strongly suggestive of Cambrian age.

Numbered localities referred to in the text are shown in figure 2, and the sources of information are given in the explanation to figure 2. Correlations are shown on five cross sections (pl. 2); the locations of these cross sections are shown on plate 2 and in figure 2.

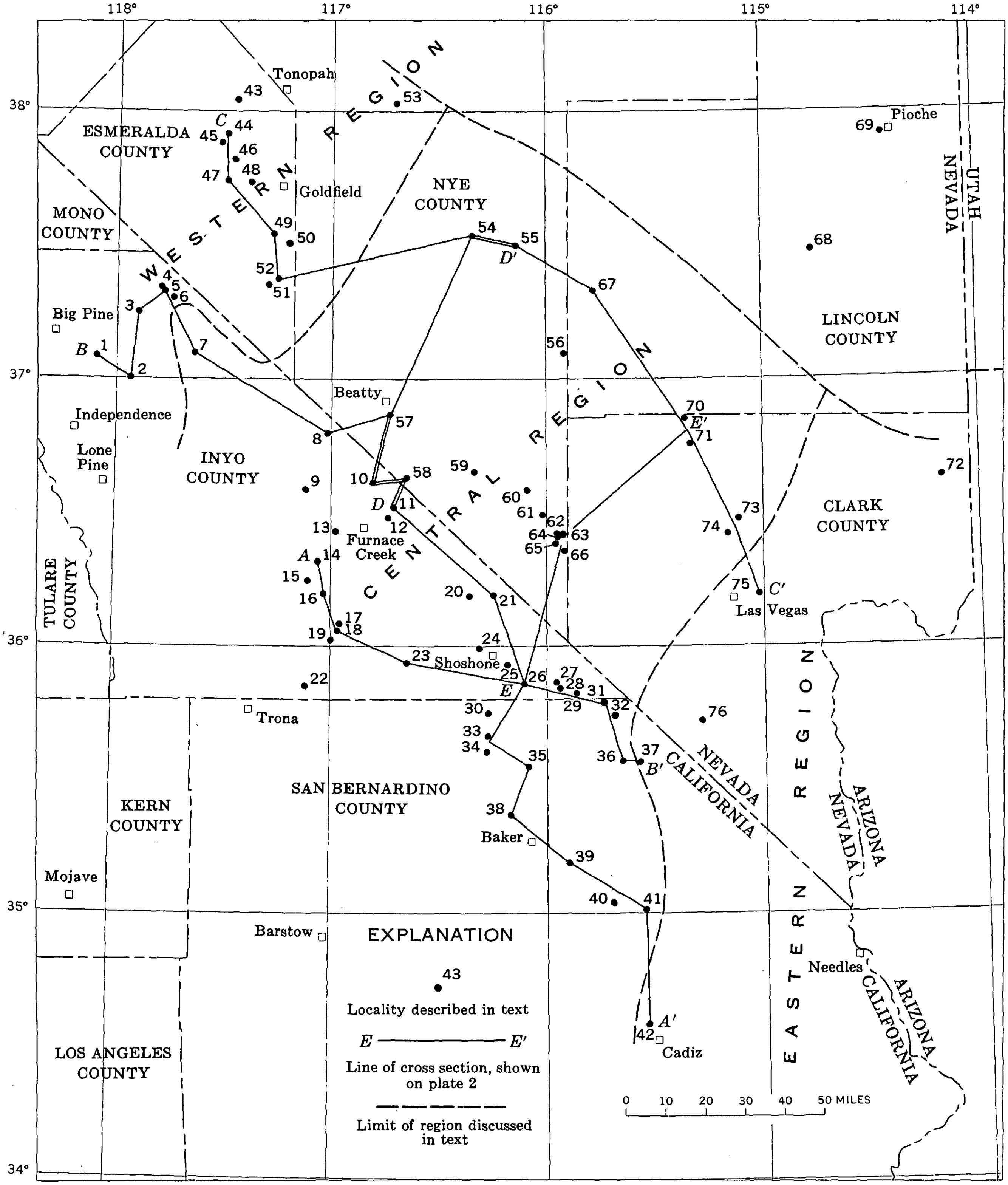

FIGURE 2.—Map showing localities, lines of cross sections, and regions discussed in text. (For description of localities see facing page.)

INDEX TO LOCALITIES SHOWN IN FIGURE 2

[Source of information on localities is as indicated]

Inyo County, Calif.

1. Andrews Mountain; secs. 1, 12, 13, and 24, T. 10 S., R. 35 E.; C. A. Nelson (written commun., 1963).
2. Waucoba Spring; secs. 9, 15, and 23, T. 11 S., R. 37 E.; Scott (1960).
3. West side of Eureka Valley; secs. 15 and 22, T. 8 S., R. 37 E.; in strat. sections this report.
4. Northern part of Last Chance Range No. 2; sec. 15 T. 7 S., R. 38 E.; Stewart (1965, fig. 14) and in strat. sections this report.
5. Northern part of Last Chance Range No. 3; secs. 14 and 24, T. 7 S., R. 38 E.; Stewart (1965, figs. 13, 14) and in strat. sections this report.
6. Northern part of Last Chance Range No. 1; secs. 31 and 32, both unsurveyed, T. 7 S., R. 39 E., and sec. 24, T. 7 S., R. 38 E.; Stewart (1965, fig. 13) and in strat. sections this report.
7. Southern part of Last Chance Range No. 1 and No. 2; secs. 7 and 8, both unsurveyed, T. 10 S., R. 40 E., and secs. 29, 30, 31, and 32, all unsurveyed, T. 9 S., R. 40 E.; Stewart (1965, fig. 14) and in strat. sections this report.
8. Titanothere Canyon; in and near sec. 30, T. 13 S., R. 46 E.; M. V. Reynolds (written commun., 1963).
9. Tucki Mountain; secs. 7 and 8, T. 16 S., R. 45 E.; J. H. Stewart (unpub. data).
10. Indian Pass; sec. 25, T. 29 N., R. 1 E., and secs. 29, 30, and 31, all unsurveyed, T. 29 N., R. 2 E.; in strat. sections this report.
11. Echo Canyon No. 2; secs. 28, 29, 31, 32, and 33, all unsurveyed, T. 28 N., R. 3 E., and sec. 5 (unsurveyed), T. 27 N., R. 3 E.; in strat. sections this report. Part of Johnnie Formation measured in sec. 6 (unsurveyed), T. 27 N., R. 3 E., and sec. 30, T. 28 N., R. 3 E.; J. H. Stewart (unpub. data). Part of Wood Canyon Formation measured near sec. 1 (unsurveyed), T. 27 N., R. 2 E.; J. F. McAllister and J. H. Stewart (unpub. data).
12. Echo Canyon No. 1; sec. 11 (unsurveyed), T. 27 N., R. 2 E.; J. F. McAllister (written commun., 1963).
13. North side of Blackwater Wash; about 3 miles west of sec. 31, T. 17 S., R. 47 E.; Hunt and Mabey (1966, p. A23).
14. Trail Canyon; sec. 1, T. 19 S., R. 45 E.; in strat. sections this report.
15. Rogers Peak; secs. 33 and 34, T. 19 S., R. 45 E.; in strat. sections this report.
16. Hanaupah Canyon; secs. 17 and 18, both unsurveyed, T. 20 S., R. 46 E.; in strat. sections this report.
17. Johnson Canyon–Starvation Canyon; sec. 25, T. 21 S., R. 46 E.; Hunt and Mabey (1966, p. A20).
18. Six Spring–Johnson Canyons; secs. 25 and 35, T. 21 S., R. 46 E., and sec. 2 (unsurveyed), T. 22 S., R. 46 E.; in strat. sections this report.
19. Arrastre Spring; sec. 15 (unsurveyed), T. 22 S., R. 46 E.; J. H. Stewart (unpub. data).
20. Eagle Mountain; sec. 20, T. 24 N., R. 6 E.; in strat. sections this report.
21. Northern part of Resting Spring Range No. 1 and No. 2; secs. 17, 18, 20, and 21, T. 24 N., R. 7 E.; in strat. sections this report.
22. Goler Wash; lat 35°51′, long 117°7′; Johnson (1957, p. 377–380) and J. H. Stewart (unpub. data).
23. Black Mountain; secs. 14 and 15, both unsurveyed, T. 21 N., R. 3 E.; in strat. sections this report.
24. Dublin Hills; sec. 26, T. 22 N., R. 6 E.; J. H. Stewart (unpub. data).
25. Southern part of Resting Spring Range; sec. 13, T. 21 N., R. 7 E.; J. H. Stewart (unpub. data).
26. Nopah Range; secs. 9, 10, and 11, T. 20 N., R. 8 E.; Hazzard (1937a, p. 278–279); in strat. sections this report; and J. H. Stewart (unpub. data).
27. Western part of Kingston Range; sec. 7, T. 20 N., R. 10 E.; J. H. Stewart (unpub. data).
28. Western part of Kingston Range; secs. 17 and 20, T. 20 N., R. 10 E.; J. H. Stewart (unpub. data).
29. Middle part of Kingston Range; sec. 25, T. 20 N., R. 10 E.; J. H. Stewart (unpub. data).

San Bernardino County, Calif.

30. Ibex Pass; sec. 19, T. 19 N., R. 7 E.; J. H. Stewart (unpub-data).
31. Winters Pass Hills; sec. 1, T. 19 N., R. 11 E.; in strat. sections this report.
32. Winters Pass; sec. 33, T. 19 N., R. 12 E.; in strat. sections this report and J. H. Stewart (unpub. data).
33. Salt Spring Hills No. 1; secs. 17 and 18, both unsurveyed, T. 18 N., R. 7 E.; in strat. sections, this report.
34. Salt Spring Hills No. 2; sec. 6 (unsurveyed), T. 17 N., R. 7 E.; in strat. sections this report.
35. Silurian Hills; sec. 24 (unsurveyed), T. 17 N., R. 8 E.; Kupfer (1960, fig. 5) and in strat. sections this report.
36. Northwest of Clark Mountain; secs. 13 and 14, T. 17 N., R. 12 E.; in strat. sections this report.
37. Northeast of Clark Mountain; sec. 15, T. 17 N., R. 13 E.; J. H. Stewart (unpub. data).
38. Silver Lake; northwestern part sec. 29 and 30, T. 15 N., R. 8 E.; in strat. sections this report.
39. Old Dad Mountain No. 1 and No. 2; sec. 25 and 26, T. 13 N., R. 10 E.; in strat. sections this report.
40. Northwest of Kelso; sec. 15, T. 11 N., R. 12 E.; J. H. Stewart (unpub. data).
41. Providence Mountains; sec. 25 (unsurveyed), T. 11 N., R. 13 E.; in strat. sections this report.
42. Marble Mountains; sec. 28, T. 6 N., R. 14 E.; in strat. sections this report.

Esmeralda County, Nev.

43. Lone Mountain; sec. 11, T. 2 N., R. 40 E.; J. H. Stewart (unpub. data).
44. Weepah Hills No. 2; secs. 25 and 26, both unsurveyed, T. 1 N., R. 40 E.; in strat. sections this report.
45. Weepah Hills No. 1; sec. 3 (unsurveyed), T. 1 S., R. 40 E.; in strat. sections this report.
46. Paymaster Ridge; secs. 25 and 36, T. 1 S., R. 40 E.; J. H. Stewart (unpub. data).
47. Clayton Ridge; sec. 25, T. 2 S., R. 40 E.; in strat. sections, this report.
48. Montezuma Peak; sec. 3, T. 3 S., R. 41 E.; J. H. Stewart (unpub. data).
49. Goldfield Hills; sec. 33, T. 4 S., R. 42 E., and sec. 4, T. 5 S., R. 42 E.; in strat. sections this report.
50. Mount Jackson Ridge; sec. 11, T. 5 S., R. 42 E.; J. H. Stewart (unpub. data).

51. Mount Dunfee; secs. 6 and 7, T. 7 S., R. 42 E.; in strat. sections this report.
52. Northeast of Mount Dunfee; secs. 33 and 34, T. 6 S., R. 42 E.; in strat. sections this report.

Nye County, Nev.

53. Southern part of Monitor Range; in and near sec. 9, T. 2 N., R. 47 E.; F. J. Kleinhampl (written commun., 1964).
54. Quartzite Mountain; sec. 13 (unsurveyed), T. 5 S., R. 50 E., and secs. 23, 25, 26, and 35, all unsurveyed, T. 4 S., R. 50 E.; in strat. sections this report.
55. Belted Range; secs. 20 and 21, both unsurveyed, T. 5 S., R. 52 E.; in strat. sections this report.
56. Halfpint Range; lat 37°8', long 115°55'; Harley Barnes and R. L. Christiansen (written commun., 1963) and Barnes, Christiansen, and Byers (1965).
57. Bare Mountain; secs. 27 and 34, T. 12 S., R. 47 E., and sec. 2, T. 13 S., R. 47 E.; Cornwall and Kleinhampl (1964, pl. 2, p. J2–J4, and written commun., 1963). E member of Stirling Quartzite measured by J. H. Stewart (unpub. data).
58. Lees Camp; 3.5–4.5 miles northwest of NW cor. T. 16 S., R. 48 E.; in strat. sections this report.
59. Lathrop Wells; secs. 15 and 22, T. 15 S., R. 50 E.; M. V. Reynolds and Harley Barnes (written commun., 1965).
60. Specter Range; secs. 11 and 12, T. 16 S., R. 52 E.; Burchfiel (1964, fig. 3c).
61. Johnnie Wash; secs. 9, 10, 15, and 16, T. 17 S., R. 53 E.; composite section after work of Nolan (1924, p. 27–28) and Burchfiel (1964).
62. Rainbow Springs; secs. 5 and 6, T. 18 S., R. 54 E.; Nolan (1924, p. 33–34).
63. Rainbow Spring; sec. 4, T. 18 S., R. 54 E.; Nolan (1924, p. 41).
64. Wood Canyon; secs. 7 and 8, T. 18 S., R. 54 E.; in strat. sections this report.
65. Wood Canyon; secs. 19 and 20, T. 18 S., R. 54 E.; Nolan (1924, p. 37–38).
66. Horse Springs; secs. 28 and 33, T. 18 S., R. 54 E.; in strat. sections this report.

Lincoln County, Nev.:

67. Groom district; lat 37°20', long 115°47'; Harley Barnes and R. L. Christiansen (1967).
68. Delamar; sec. 36 (unsurveyed), T. 15 S., R. 64 E.; J. H. Stewart (unpub. data).
69. Pioche; sec. 26, T. 1 N., R. 67 E.; J. H. Stewart (unpub. data).

Clark County, Nev.

70. Desert Range Nos. 1 and 2; lat 36°48', long 115°20', and lat 36°50' N., long 115°22'; Stewart and Barnes (1966, fig. 7) and in strat. sections this report.
71. Desert Range Nos. 3 and 4; lat 36°44' N., long 115°21' W. to 115°22' W.; Stewart and Barnes (1966, fig. 8) and in strat. sections this report.
72. Virgin Mountains; sec. 21, T. 15 S., R. 70 E.; J. H. Stewart (unpub. data).
73. Las Vegas Range No. 2; secs. 13 and 14, both unsurveyed, T. 17 S., R. 61 E.; in strat. sections this report.
74. Las Vegas Range No. 1; sec. 4, T. 18 S., R. 61 E. and sec. 33, unsurveyed, T. 17 S., R. 61 E.; in strat. sections this report.
75. Frenchman Mountain; sec. 23, T. 20 S., R. 62 E.; J. H. Stewart (unpub. data).
76. Sheep Mountain; sec. 5, T. 26 S., R. 60 E.; J. H. Stewart (unpub. data).

EASTERN REGION

In the eastern part of the southern Great Basin, a sequence of strata that is mostly Early Cambrian in age, but which locally may be late Precambrian in the lowermost part, rests unconformably on lower Precambrian gneiss and schist. This sequence is only a few hundred feet thick and consists of a basal unit of sandstone, quartzite, and conglomerate and an overlying unit of shale, siltstone, and limestone. The sequence is a shelf facies east of the upper Precambrian and Lower Cambrian miogeosynclinal belt.

The basal unit of sandstone, quartzite, and conglomerate has most commonly been called the Tapeats Sandstone (Longwell, 1928; Hewett, 1956, p. 32–34; Longwell and others, 1965, p. 15), although in the northern part of the region, the unit has also been called Prospect Mountain Quartzite (Wheeler, 1943; McNair, 1951, p. 507–512; Lochman-Balk, 1956, p. 561; Tschanz and Pampeyan, 1961). The Tapeats Sandstone was named by Noble (1914) in the Grand Canyon area of northern Arizona about 100 miles east of the eastern part of the region discussed here. In the type area, it is a thin sandstone unit lying unconformably on Precambrian stratified rocks in some places and on older Precambrian gneiss and schist in others. The Prospect Mountain Quartzite was named by Hague (1883, p. 254) in the Eureka district about 200 miles north of the northern part of the region discussed here. In the type area, the base of the Prospect Mountain is not exposed, and an incomplete section is about 1,500 feet thick. In the eastern region of the southern Great Basin, the sandstone, quartzite, and conglomerate unit is thinner than the type Prospect Mountain, but has the same general thickness as the type Tapeats. In addition, the unit in the southern Great Basin and the Tapeats are similar in that they both lie in places on lower Precambrian gneiss and schist. The name Tapeats therefore seems to be appropriate and is adopted here for the basal unit in the eastern region. Such a practice largely follows previous usage.

One change from previous usage of the name Tapeats is in the Providence Mountains (loc. 41 in strat. sections). Here a section about 1,200 feet thick composed dominantly of quartzite has been called Tapeats Sandstone by Hewett (1956, p. 34) and Prospect Mountain Quartzite by Hazzard (1954, p. 30). This section is several times thicker than the strata to the east that the writer feels should be called Tapeats, and, in addition, it contains units that are correlative with the Johnnie Formation, Stirling Quartzite, Wood Canyon Formation, and Zabriskie Quartzite, formations that are of wide extent in the central region of the southern Great

Basin. This thick section in the Providence Mountains is not similar to the Tapeats as recognized in its type area; thus the names Johnnie, Stirling, Wood Canyon, and Zabriskie are used instead of Tapeats.

The name Tapeats Sandstone as used in this report refers to a thin shelf deposit that is laterally equivalent to part of a thicker sequence to the west. Such usage, however, leads to some inconsistencies. For example, the Tapeats, as employed here, extends into the Marble Mountains (loc. 42) and the Clark Mountain (loc. 37) area along the western margin of the shelf facies, even though the Tapeats in these areas is composed of strata that are correlative with units in the central region of the southern Great Basin. An alternate approach would be to use the nomenclature of the central region in the Marble Mountains and the Clark Mountain area and to restrict the name Tapeats to strata farther east. Such a practice is not followed here, however. Instead, the name Tapeats is consistently applied to the thin basal clastic strata in the eastern part of the southern Great Basin.

The Tapeats Sandstone is lithologically variable from place to place. In the Virgin Mountains (loc. 72), the Frenchman Mountain area (loc. 75, pl. 2), and Sheep Mountain (loc. 76), it consists of grayish-red, pale-red, and very pale orange fine- to coarse-grained sandstone and minor amounts of quartzite. Some conglomerate layers occur, particularly in the lower part of the unit; they contain granules, pebbles, and, locally, small pebbles of quartz and quartzite and sparse small cobbles of red chert. The sandstone and quartzite are commonly cross-stratified on a small scale, and three studies (table 2) of the direction of dip of the cross-strata indicate generally westward current directions. The Tapeats in these areas is 150–400 feet thick.

TABLE 2.—*Summary of cross-stratification data*

Stratigraphic unit and locality	Reference letter (used in figs. 3, 9, 15, 25)	County and State	Location	Number of readings	Azimuth of vector mean, in degrees	Standard deviation	Vector strength (consistency ratio)
Tapeats Sandstone:							
Frenchman Mountain		Clark, Nev	Sec. 13, T. 20 S., R. 62 E	37	255	49	0.70
Sheep Mountain		Clark, Nev	Sec. 5 (unsurveyed), T. 25 S., R. 60 E.	23	335	74	.62
Virgin Mountains		Clark, Nev	Sec. 21, T. 15 S., R. 70 E	31	258	32	.88
Zabriskie Quartzite and laterally equivalent strata: [1]							
Andrews Mountain	A	Inyo, Calif	Secs. 12 and 13 (unsurveyed), T. 10 S., R. 35 E.	8	293	65	.67
Horse Springs	B	Nye, Nev	Secs. 27 and 28, T. 18 S., R. 54 E.	30	332	43	.76
Last Chance Range	C	Inyo, Calif	Sec. 7 (unsurveyed), T. 10 S., R. 40 E.	30	273	58	.56
Marble Mountains	D	San Bernardino, Calif.	Sec. 21, T. 6 N., R. 14 E	7	257	83	.44
Pioche	E	Lincoln, Nev	Sec. 26, T. 1 N., R. 67 E	24	280	52	.65
Wood Canyon Formation middle member and laterally equivalent strata: [2]							
Bare Mountain	A	Nye, Nev	Sec. 34, T. 12 S., R. 47 E	33	346	40	.79
Clark Mountain No. 1	B	San Bernardino, Calif.	Sec. 13, T. 17 N., R. 12 E	46	312	42	.80
Clark Mountain No. 2	C	San Bernardino, Calif.	Sec. 15, T. 17 N., R. 13 E	30	281	40	.80
Desert Range	D	Lincoln, Nev	Lat 36°44′ N., long 115°22′ W	50	358	70	.47
Dublin Hills	E	Inyo, Calif	Sec. 24, T. 22 N., R. 6 E	50	354	77	.52
Echo Canyon	F	Inyo, Calif	Sec. 34 (unsurveyed) T. 28 N., R. 3E.	50	357	55	.65
Groom district	G	Lincoln, Nev	Lat 37°20′ N., long 115°47′ W	50	275	83	.33
Horse Springs	H	Nye, Calif	Sec. 28, T. 18 S., R. 54 E	50	279	43	.79
Ibex Hills	I	Inyo, Calif	Sec. 32, T. 21 N., R. 6 E	50	34	42	.79
Kingston Range	J	Inyo, Calif	Sec. 22 (unsurveyed), T. 20 N., R. 11 E.	30	271	38	.81
Las Vegas Range	K	Clark, Nev	Sec. 27 (unsurveyed), T. 17 S., R. 61 E.	36	351	52	.72
Marble Mountains	L	San Bernardino, Calif.	Sec. 28, T. 6 N., R. 14 E	50	36	31	.87
McLain Flat	M	Inyo, Calif	Secs. 22 and 23 (unsurveyed), T. 20 N., R. 6 E.	30	58	32	.87
Nopah Range No. 1	N	Inyo, Calif	Sec. 24, T. 20 N., R. 8 E	50	325	62	.59
Nopah Range No. 2	O	Inyo, Calif	Sec. 10, T. 20 N., R. 8 E	30	304	46	.72
Providence Mountains	P	San Bernardino, Calif.	Secs. 25 and 36 (unsurveyed), T. 11 N., R. 13 E.	50	297	50	.68

See footnotes at end of table.

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TABLE 2.—*Summary of cross-stratification data*—Continued

Stratigraphic unit and locality	Reference letter (used in figs. 3, 9, 15, 16)	County and State	Location	Number of readings	Azimuth of vector mean, in degrees	Standard deviation	Vector strength (consistency ratio)
Resting Spring Range	Q	Inyo, Calif	Sec. 17, T. 24 N., R. 7 E	50	297	43	.75
Salt Spring Hills	R	San Bernardino, Calif.	Sec. 18 (unsurveyed), T. 18 N., R. 7 E.	50	305	65	.50
Trail Canyon	S	Inyo, Calif	Sec. 25 (unsurveyed), T. 18 S., R. 45 E.	50	307	42	.78
Tucki Mountain	T	Inyo, Calif	Sec. 7, T. 16 S., R. 45 E	50	358	53	.67
Virgin Spring	U	Inyo, Calif	Sec. 31, T. 22 N., R. 4 E	36	62	34	.84
Winters Pass	V	San Bernardino, Calif.	Sec. 33, T. 25 S., R. 12 E	50	293	32	.86
Stirling Quartzite:							
E member:							
Bare Mountain No. 1	A	Nye, Nev	Secs. 21 and 28, T. 12 S., R. 47 E.	30	322	34	0.84
Bare Mountain No. 2	B	Nye, Nev	Sec. 34, T. 12 S., R. 47 E	17	271	51	.74
Clark Mountain	C	San Bernardino, Calif.	Sec. 13, T. 17 N., R. 12 E	19	296	11	.98
Desert Range	D	Lincoln, Nev	Lat 36°44′ N., long 115°22′ W.	30	224	56	.74
Horse Springs	E	Nye, Nev	Secs. 28 and 29, T. 18 S., R. 54 E.	50	271	29	.89
Las Vegas Range	F	Clark, Nev	Sec. 1 (unsurveyed), T.1 7S., R. 61 E.	6	248	23	.93
Nopah Range	G	Inyo, Calif	Sec. 10, T. 20 N., R. 8 E	30	274	42	.78
Providence Mountains	H	San Bernardino, Calif.	Secs. 25 and 36 (unsurveyed), T. 11 N., R. 13 E.	30	230	31	.87
Quartzite Mountain	I	Nye, Nev	Sec. 23 (unsurveyed), T. 4 S., R. 50 E.	30	267	44	.77
Salt Spring Hills	J	San Bernardino, Calif.	Sec. 18 (unsurveyed), T. 18 N., R. 7 E.	31	270	71	.44
Trail Canyon	K	Inyo, Calif	Sec. 31 (unsurveyed), T. 18 S., R. 46 E.	30	314	62	.57
Winters Pass Hills	L	San Bernardino, Calif.	Sec. 1 (unsurveyed), T. 19 N., R. 11 E.	27	252	35	.84
A and B members:[3]							
Desert Range	M	Lincoln, Nev	Lat 36°44′ N., long 115°22′ W	31	245	46	.79
Echo Canyon	N	Inyo, Calif	Sec. 5 (unsurveyed), T. 27 N., R. 3 E.	33	262	34	.84
Groom district No. 1	O	Lincoln, Nev	Lat 37°22′ N., long 115°48′ W.	9	222	27	.90
Groom district No. 2	P	Lincoln, Nev	Lat 37°22′ N., long 115°48′ W	30	235	62	.53
Nopah Range	Q	Inyo, Calif	Sec. 10, T. 20 N., R. 8 E	35	253	53	.66
Panamint Range	R	Inyo, Calif	Sec. 6, T. 19 S., R. 46 E	34	256	36	.83
Quartzite Mountain	S	Nye, Nev	Sec. 13 (unsurveyed), T. 5 S., R. 50 E.	30	224	36	.83
Resting Spring Range	T	Inyo, Calif	Sec. 21, T. 24 N., R. 7 E	30	317	42	.77
Salt Spring Hills	U	San Bernardino, Calif.	Sec. 18 (unsurveyed), T. 18 N., R. 7 E.	31	251	71	.46
Trail Canyon	V	Inyo, Calif	Sec. 6 (unsurveyed), T. 19 S., R. 46 E.	32	324	58	.57
Wood Canyon	W	Nye, Nev	Sec. 7, T. 18 S., R. 54 E	30	287	30	.87
Johnnie Formation:[4]							
Desert Range	A	Lincoln, Nev	Lat 36°48′ N., long 115°20′ W.	32	266	18	.95
Nopah Range	B	Inyo, Calif	Sec. 10, T. 20 N., R. 8 E	18	195	20	.94
Winters Pass Hills	C	San Bernardino, Calif.	Sec. 1, T. 19 N., R. 11 E	11	253	53	.64

[1] Data at Andrews Mountain from quartzite in middle of Harkless Formation; data at Marble Mountains from part of Tapeats Sandstone that is correlative to Zabriskie Quartzite; data at other localities from Zabriskie Quartzite.

[2] Data at Clark Mountain No. 2 and at Marble Mountains from part of Tapeats Sandstone that is correlative to middle member of Wood Canyon Formation.

[3] Data at Groom district No. 2 from B member; data at other localities from A member.

[4] Data at Desert Range from middle part of lower quartzite and siltstone member of Stewart and Barnes (1966); data at Nopah Range from top 100 feet of unit 2D (quartzite member of this report) of Hazzard (1937a, fig. 3e); data at Winters Pass Hills from units 6 and 7 (quartzite member), Winters Pass Hills stratigraphic section.

In the Marble Mountains (loc. 42, pl. 2) and the Clark Mountain area (loc. 37, pl. 2), the Tapeats Sandstone consists of strata that differ in part from those in the previously described areas and that are correlative with units in the central region of the southern Great Basin. In the Marble Mountains, the Tapeats consists of three units, which are, in ascending order: (1) a 320-foot unit of greenish-gray fine- to medium-grained locally conglomeratic quartzite, (2) a 90-foot unit of dark-greenish-gray siltstone and very fine grained micaceous quartzite containing *Scolithus* tubes, and

(3) a 70-foot unit of very light gray fine- to medium-grained quartzite. The lower and middle units are lithologically similar and are correlated with the middle and upper members, respectively, of the Wood Canyon Formation of the central region. The upper unit is correlated with the Zabriskie Quartzite (pl. 2) of the central region.

In the eastern part of the Clark Mountain area (loc. 37, pl. 2), the Tapeats Sandstone consists of a lower unit, 170 feet thick, composed of medium-gray to grayish-purple medium- to coarse-grained locally conglomeratic quartzite and an upper unit, about 25 feet thick, composed of yellowish-gray fine- to medium-grained quartzite. The lower unit is correlated with the middle member of the Wood Canyon Formation of the central region, and the upper unit with the Zabriskie Quartzite of the central region (pl. 2).

The Tapeats Sandstone is considered to be Early Cambrian in age, although part may be late Precambrian. An Early Cambrian age is indicated by the reported presence (Hewett, 1956, p. 33 and 37) of brachiopods and trilobites in the Tapeats in the Sheep Mountain area (loc. 76). This age is also suggested by the recognition locally in the Tapeats of strata that are correlative with the upper member of the Wood Canyon Formation and the Zabriskie, which are dated as Early Cambrian in areas to the west. The recognition in places in the Tapeats of strata that are equivalent to the middle member of the Wood Canyon Formation, however, suggests that the lower part of the Tapeats may be Precambrian because the middle member of the Wood Canyon is considered to be Precambrian in areas to the west.

The Tapeats Sandstone is overlain by a several-hundred-foot sequence of shale, siltstone, sandstone, and limestone that ranges in age from Early to Middle Cambrian in age. In most of the eastern region of the southern Great Basin, this sequence is called the Bright Angel Shale (Longwell, 1928; Hewett, 1956, p. 34–37). The Bright Angel Shale is Middle Cambrian in age in the eastern part of the Grand Canyon area in Arizona, but Early and Middle Cambrian near the Arizona-Nevada State line (McKee and Resser, 1945, fig. 2B and p. 193) and is probably also Early and Middle Cambrian in California and Nevada. An Early and Middle Cambrian age for the Bright Angel in Nevada and California is also supported by the correlation of the Bright Angel with other formations known to range in age from Early to Middle Cambrian. In the Marble and Providence Mountains, Calif., for example, strata correlative with the Bright Angel are assigned, in ascending order, to the Latham Shale and the Chambless Limestone of Early Cambrian age, and the Cadiz Formation of Early and Middle Cambrian age (Hazzard and Mason, 1936; Hazzard, 1938; and Hazzard, 1954). In the northern and eastern part of the eastern region of the southern Great Basin, strata correlative with the Bright Angel Shale have been assigned, in ascending order, to the Pioche Shale of Early and Middle Cambrian age, and the Lyndon Limestone and Chisholm Shale of Middle Cambrian age (Tschanz and Pampeyan, 1961; Wheeler, 1943; McNair, 1951, p. 507–512; Lochman-Balk, 1956, p. 56).

CENTRAL REGION

The upper Precambrian and Lower Cambrian strata in the central region of the southern Great Basin form a westward-thickening wedge of quartzite, conglomerate, siltstone, and carbonate that is over 13,000 feet thick in the western part of the region. They lie west of the thin shelf deposits (Tapeats Sandstone and Bright Angel Shale) of the eastern region and are along the eastern edge of the Cordilleran miogeosynclinal belt. To the west, they grade into finer grained strata.

The nomenclature of the central region is entirely different from that of the eastern or western regions (table 1). Although strata that are correlative with rocks in the adjacent regions are locally recognized in the central region, they cannot be mapped separately. The boundary between the eastern and central nomenclatural regions separates thin shelf deposits on the east from thicker miogeosynclinal deposits on the west. Although the distinction between the two types of deposits is not everywhere clear, the boundary as drawn on plate 1 seems to be a practical place for this change in nomenclature and is largely in accordance with previous usage.

The western boundary of the central region separates strata on the east that resemble formations defined in the Spring Mountains–Death Valley area of the central region from strata on the west that resemble formations defined in the White and Inyo Mountains of the western region. This boundary is easily drawn along much of its extent, and only in the Last Chance Range area do strata characteristic of the two regions crop out close together. In this area, the boundary is drawn on the basis of facies in the Zabriskie Quartzite and laterally equivalent parts of the Harkless and Saline Valley Formations. In or near outcrops where the Zabriskie interval is a massive quartzite unit and thus resembles typical Zabriskie, the nomenclature of the central region is used; where the Zabriskie interval contains many or numerous siltstone layers and is thus unlike typical Zabriskie but is similar to the Harkless and Saline Valley Formations, the nomenclature of the western region is used.

The Pahrump Group is the oldest upper Precambrian assemblage of sedimentary rocks in the central region. It is unconformably (or perhaps in places conformably) overlain by upper Precambrian and Lower Cambrian strata that are divided into six formations (table 1). The writer has studied four formations (Johnnie, Stirling, Wood Canyon, and Zabriskie) in detail, but brief descriptions of the Pahrump Group, Noonday Dolomite, and Carrara Formation are included to complete the general stratigraphic picture. Brief descriptions of the Pahrump Group and Noonday Dolomite, however, are inadequate because of the complex internal stratigraphy of these rocks. The Pahrump Group and Noonday Dolomite have been more thoroughly described by Wright and Troxel (1966, 1967), and the reader is referred to their work.

PAHRUMP GROUP

The Pahrump Series was named by Hewett (1940, p. 239–240) for a 7,000–8,000-foot-thick section of rocks consisting of sandstone, conglomerate, quartzite, shale, and dolomite. Kupfer (1954, 1960) relegated the Pahrump to group rank, the usage herein employed. The Pahrump Group is divided into three formations—the Crystal Spring Formation at the base, the Beck Spring Dolomite in the middle, and the Kingston Peak Formation at the top. These units crop out in Death Valley and adjacent areas (pl. 1). They are late Precambrian and are the oldest strata that rest on lower Precambrian gneiss and schist; correlative strata have not been recognized elsewhere in the southern Great Basin.

The Crystal Spring Formation was named (Hewett, 1940, p. 240) for outcrops in the Kingston Range. It crops out at many localities between the Kingston Range and Death Valley (Wright, 1952, 1954; Wright and Troxel, 1967), in the Silurian Hills (Kupfer, 1960), and in the southern part of the Panamint Range (Albee and Lanphere, 1963; Lanphere and others, 1963; Hunt and Mabey, 1966; Wright and Troxel, 1967). Troxel and Wright (1968) have suggested that correlative strata may also crop out in the Funeral Mountains. The Crystal Spring Formation rests unconformably on older Precambrian gneiss and schist and is composed of quartzite, conglomeratic quartzite, shale, limestone, dolomite, and chert. In most areas, it is between 2,000 and 4,000 feet thick. Talc deposits (Wright, 1957, p. 624–627) are common in a carbonate member of the formation where the member has been intruded by a persistent sill of diabase of probable late Precambrian age. This carbonate member changes in lithologic character from a dominantly carbonate rock in the northeast to shale and quartzite with subordinate amounts of carbonate in the southwest (Wright and Troxel, 1967, p. 940, fig. 5).

According to Wrucke (1966), the Crystal Spring Formation is lithologically similar to the Apache Group of southern Arizona and the Unkar Group of the Grand Canyon in northern Arizona. These units are characterized by shale and siltstone, algal carbonate rocks, and sills of diabase (dolerite). The Apache and Unkar Groups may therefore be correlative with the Crystal Spring, and if this is true, the Crystal Spring Formation could be older than 1.1 billion years, the radiometric age determined for diabase sills in the Apache Group in southern Arizona.

The Beck Spring Dolomite (named by Hewett, 1940, p. 240) occurs in the same general area as the Crystal Spring Formation. This unit has been referred to locally in the Panamint Range as the Marvel Dolomitic Limestone (Murphy, 1932, p. 343–344). The Beck Spring Dolomite consists almost entirely of gray thick-bedded dolomite and is over 1,100 feet thick in the Kingston Range (Hewett, 1956, p. 26). It thins to the south to about 150 feet in the Silurian Hills and may be absent southwest of there (Wright and Troxel, 1967, p. 940–942, fig. 5).

The Kingston Peak Formation (named by Hewett, 1940, p. 240), the highest formation in the Pahrump Group, occurs in the same areas as the lower two formations in the group and, in addition, is recognized in the northern part of the Panamint Range (Lamphere, 1962) and tentatively in the Funeral Mountains (Hunt and Mabey, 1966, p. A15; Troxel and Wright, 1968). The Kingston Peak consists of a thick sequence of conglomerate, conglomeratic mudstone, quartzite, sandstone, siltstone, and shale. The most characteristic lithologic type in the formation is conglomeratic mudstone that contains large clasts (some of which are several feet in diameter) of dolomite, quartzite, granitic rock, and gneiss. Some of the dolomite clasts are identical in lithology to the Beck Spring Dolomite, and others are identical to the dolomite of the Crystal Spring Formation. The conglomeratic mudstone layers could be tillites, as tentatively suggested by Hazzard (1937b, p. 215) and discussed by Johnson (1957, p. 368–369), although some units contain graded beds that are suggestive of deposition by turbidity currents. In the Panamint Range a conspicuous limestone unit, the Sour Dough Limestone Member of Johnson (1957, p. 365), occurs in the middle of the Kingston Peak Formation. In areas east of Death Valley, the Kingston Peak thickens to the southwest and is locally about 3,000 feet thick. In at least a part of the Panamint Range, however, the formation thickens to the northwest (Johnson, 1957, p. 361) to a maximum of 2,700 feet.

NOONDAY DOLOMITE

The Noonday Dolomite (named by Hazzard, 1937a, p. 300–301) consists typically of thick massive light-colored cliff-forming dolomite and, where typically developed, is one of the most distinctive formations in Death Valley and adjacent areas. The Noonday and correlative strata are recognized only in the central region of the southern Great Basin. Either it was not deposited as far east as the eastern region, or it was deposited and was subsequently removed by erosion. No strata correlative to the Noonday are known in the western region, and all the exposed strata there are perhaps younger than the Noonday.

The Noonday has been considered to be Cambrian in age by some geologists (Hazzard, 1937a, p. 279; Hewett, 1956, p. 28) and Precambrian by others (Hunt and Mabey, 1966, table 1; Stewart, 1966). In westernmost exposures, the Noonday lies nearly 7,000 feet below the lowest known occurrence of olenellid trilobites and archeocyathids and about 5,000 feet below the lowest known occurrence of trace fossils such as tracks and trails that are indicative of metazoan life. It is considered herein to be Precambrian because it lies below the olenellid-archeocyathid fauna.

The Noonday Dolomite crops out mostly in the area extending from the Kingston Range westward to Death Valley and in the area of the Panamint Range. South of the Kingston Range area, the Noonday is apparently missing in the Silurian Hills (Wright and Troxel, 1966, fig. 2) and in most of the Clark Mountain area (Hewett, 1956, pl. 1), although the Noonday does occur in at least one locality near Clark Mountain (Hewett, 1956, fig. 18). In the Panamint Range the exact correlations of the Noonday have not been worked out, but most or all of the unit may pinch or grade out northward. The Noonday is absent or represented only by a thin layer of sandy dolomite in the Funeral Mountains (Wright and Toxel, 1966, p. 847; Troxel and Wright, 1968), which contain the most northerly outcrops of related Precambrian strata in the Death Valley region.

At the type locality in the southern part of the Nopah Range (loc. 26), the Noonday Dolomite is divided into two parts (Hazzard, 1937a, p. 300; Wright and Troxel, 1966, fig. 4, and 1967). The lower part (the algal dolomite member) consists of massive light-colored dolomite and contains vertical tubular structures (Hunt and Mabey, 1966, fig. 9); these structures resemble *Scolithus* tubes, but are possibly of algal origin. The upper part (the sandy dolomite member) consists of clastic dolomite that is commonly cross-stratified. Detrital quartz grains are common in the upper member. In the type area the Noonday is 1,500 feet thick; approximately the lower two-thirds belongs to the algal dolomite member and the upper third to the sandy dolomite member.

These two members constitute the entire Noonday Dolomite from the eastern part of the Kingston Range westward to Death Valley. Southwest of these areas, on the east side of Death Valley, a wedge of clastic material (termed the "clastic wedge" by Wright and Troxel, 1967, p. 943, fig. 8), occurs between the two members. This wedge consists of lavender shale and graywacke (Wright and Troxel, 1967, p. 943) and thickens to the southwest.

In part of the southern Panamint Range, the Noonday is lithologically similar to the Noonday in its type area in the Nopah Range, but in the central and northern part of the Panamint Range a different lithologic unit occurs between the algal dolomite and the sandy dolomite members. This unit consists of laminated silty and sandy limestone; it was first described by Murphy (1932, p. 349), who named it the Radcliff Formation. Since Murphy's work, the name Noonday has been extended into the Panamint Range, and as now recognized, the algal dolomite member is what Murphy called Sentinel Dolomite, the laminated limestone is the Radcliff Formation, and the sandy dolomite is approximately the lower half of Murphy's Redlands Dolomitic Limestone.

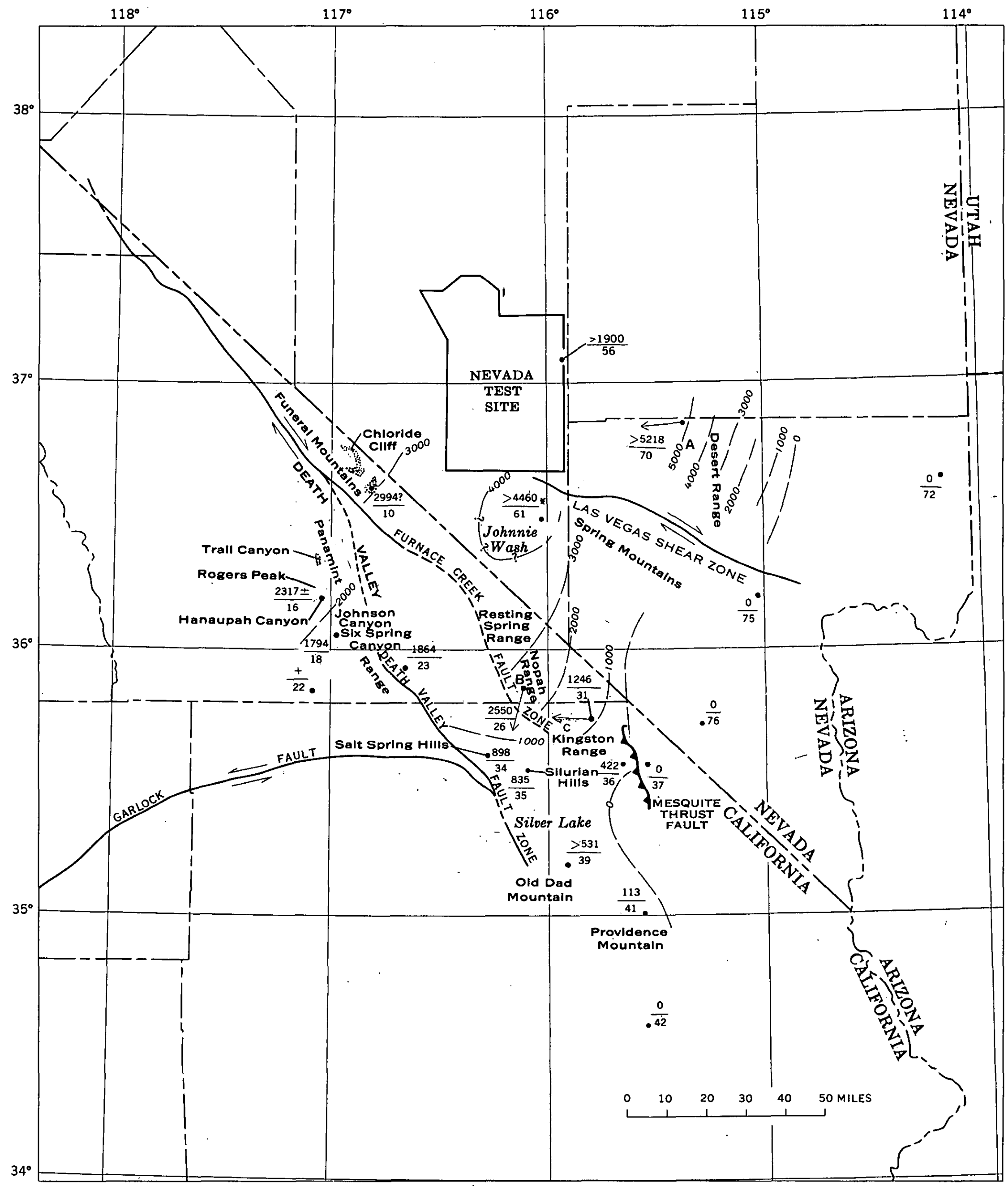
The clastic wedge on the east side of the Death Valley area and the laminated limestone in the Panamint Range west of Death Valley are lithologically distinct, although they occupy a similar stratigraphic position within the Noonday. Areas where the clastic wedge and the laminated limestone occur appear to be separated by areas where the entire Noonday is composed only of the algal dolomite and sandy dolomite members.

In much of its area of exposure, the Noonday Dolomite rests unconformably on the underlying rocks, and in places the unconformity is noticeably angular. The unconformity is particularly well exposed between Death Valley and the Kingston Range, where the Noonday truncates the Pahrump Group to the north. In the southern part of this area, the Noonday rests on the Kingston Peak Formation, farther north on the Beck Spring Dolomite, still farther north on the Crystal Spring Formation, and finally on older Precambrian gneiss and schist (Wright and Troxel, 1967, fig. 3). These relationships indicate a significant unconformity, but the extent of the unconformity is uncertain. That no angularity is detectable between the Noonday and the Kingston Peak at some places in the southern part of this area suggests that the pre-Noonday unconformity may die out to the south (B. W. Troxel, oral commun., 1965). An unconformity between the Noonday and the Kingston Peak is also difficult to detect in parts of the Panamint Range (Johnson, 1957, p. 370).

The contact between the Noonday Dolomite and the overlying Johnnie Formation is placed at the base of the lowest quartzite in the Noonday-Johnnie interval, following the practice of Hazzard (1937a, fig. 3e). The contact, however, is commonly inconspicuous because the lower part of the Johnnie Formation contains abundant carbonate strata that are similar to those in the Noonday, and the amount of quartzite is small. In general, the contact marks a change from thick-bedded massive dolomite and sandy dolomite below to thinner bedded carbonate and clastic strata above.

JOHNNIE FORMATION

The Johnnie Formation (named by Nolan, 1929, p. 461–463) has been recognized over an area of about 10,000 square miles in the central region of the southern Great Basin (fig. 3). It consists of a heterogeneous and in part laterally variable sequence of shale, siltstone, quartzite, conglomerate, limestone, and dolomite. It is a westward-thickening wedge of sedimentary rock that is locally over 5,000 feet thick. The Johnnie contrast with the underlying Noonday Dolomite, which is typically a thick massive cliff-forming dolomite, and with the overlying Stirling Quartzite, which is composed of cliff-forming quartzite and minor amounts of siltstone and carbonate. The Johnnie is recognized only in the central region of the southern Great Basin. Some of the lower part of the Wyman Formation, a formation of the western region of the southern Great Basin, is composed of



EXPLANATION

898 / 34   + / 22

Measured section

Upper number indicates thickness in feet; lower number indicates locality listed in figure 2; plus sign indicates unknown thickness.

Outcrop containing granule conglomerate

?—— 3000

Isopach

Contour interval 1000 feet. Queried where uncertain

A ——→

Resultant dip direction of cross-strata. Azimuth of vector mean

Base of arrow is location of study; letter indicates locality and data listed in table 2 showing cross-stratification data

Strike-slip fault or shear zone

Dashed where inferred. Arrows indicate relative movement

Thrust fault

Sawteeth on upper plate

FIGURE 3.—Isopach map of the Johnnie Formation showing resultant dip directions of cross-strata and the location of outcrops containing granule conglomerate.

phyllitic siltstone, silty claystone, and minor amounts of carbonate and sandstone and could conceivably be laterally equivalent to part of the Johnnie; however, the correlation is uncertain because the nearest outcrops of the Johnnie and of the Wyman are about 35 miles apart.

The Johnnie Formation has been considered to be Cambrian by some geologists (Nolan, 1929, p. 463; Hazzard, 1937a, p. 279) and Precambrian by other geologists (Barnes and others, 1965; Hunt and Mabey, 1966, table 1; Stewart, 1966). It is locally about 8,000 feet below the lowest known occurrence of olenellid trilobites or archeocyathids and 5,000 feet below the lowest known occurrence of trace fossils that are indicative of metazoan life. It is therefore considered here to be Precambrian.

In the Providence Mountains, the Johnnie Formation of this report is the basal part of the unit that Hewett (1956, p. 32–34) called the Tapeats Sandstone and Hazzard (1954, p. 30) the Prospect Mountain Quartzite. The reasons for not using the name Tapeats Sandstone or Prospect Mountain Quartzite in the Providence Mountains have already been discussed. (See discussion under "Eastern region.") In the Kingston Range and Clark Mountain areas, the Johnnie Formation of this report is also the basal part of the Prospect Mountain Quartzite as mapped by Hewett (1956, p. 26–31); however, the name Prospect Mountain Quartzite does not seem appropriate in the Kingston Range and Clark Mountain areas because the strata that compose this unit can be divided into four lithologically distinct formations. They are, in ascending order, the Johnnie Formation, the Stirling Quartzite, the Wood Canyon Formation, and the Zabriskie Quartzite. These formations have been previously recognized in the Kingston Range area by Wright and Troxel (1966) and have been mapped in the Clark Mountain area by B. C. Burchfiel and G. A. Davis (oral commun., 1966). The Johnnie, Stirling, Wood Canyon, and Zabriskie are easily recognized in the sequence that Hewett called Prospect Mountain Quartzite, and they can be traced with assurance into areas where the Johnnie–Stirling–Wood Canyon–Zabriskie nomenclature has been used universally. Use of the name Prospect Mountain Quartzite in the Kingston Range and Clark Mountain areas further seems inappropriate because the type area of this formation is in central Nevada 300 miles to the north, whereas the type areas of the Johnnie, Stirling, Wood Canyon, and Zabriskie are in nearby parts of the southern Great Basin.

The Johnnie Formation is most extensively exposed in the southern part of the Death Valley area and in the Kingston Range area, California, but outcrops also occur in the Funeral Mountains, Calif. (loc. 10), at the northwest end of the Spring Mountains (loc. 61, the type locality), in the Nevada Test Site and vicinity (loc. 56), and in the Desert Range, Nev. (loc. 70).

The Johnnie Formation rests conformably on the Noonday Dolomite in most areas where the base of the formation is exposed. In the southern part of the Death Valley area, however, the Johnnie extends beyond the limit of the Noonday and rests on the Kingston Peak Formation in the Silurian Hills (loc. 35) and on older Precambrian gneiss and schist in the Providence Mountains (loc. 41). In the Funeral Mountains the Noonday is absent, or represented only by thin sandy dolomite layers in the basal part of the Johnnie Formation, and the contact between the Johnnie and the underlying rocks is an angular unconformity. (See description of the Johnnie Formation in the section on the "Funeral Mountains area, California.") The base of the Johnnie is not exposed north or northeast of the Death Valley area.

The Johnnie Formation conformably underlies the Stirling Quartzite, except possibly in the Salt Spring Hills (loc. 34), the Silurian Hills (loc. 35), and Silver Lake (loc. 38) areas and in areas farther south, where an erosional break may occur between the two formations. (See description under "Stirling Quartzite.")

The Johnnie Formation ranges in thickness from about 100 feet to over 5,000 feet (table 3; fig. 3). The base is not exposed where the formation is thickest (Spring Mountains, loc. 61, and Desert Range, loc. 70), and the maximum thickness of the formation is therefore not known. The formation may be thicker in the Spring Mountains area than it is either southeast or northwest of that locality, but thickness trends are difficult to determine because of the limited exposures of the formation.

Separate descriptions of the Johnnie Formation are given for each of the following areas: southern Death Valley–Kingston Range, Spring Mountains, Desert Range, and Funeral Mountains. This is done to describe the lithologic changes of the formation in the region. The Johnnie Formation, except for the topmost part, has not been studied by the writer in the Nevada Test Site and vicinity, and thus a description of the formation in this area is not included. Information on the Johnnie in this area is given by Barnes, Christiansen, and Byers (1962) and by Barnes and Christiansen (1967). The regional characteristics of the Johnnie are described under a separate heading after the descriptions of the formation in the various areas.

SOUTHERN DEATH VALLEY–KINGSTON RANGE AREA, CALIFORNIA

The Johnnie Formation in the southern Death Valley–Kingston Range area is divided here into six members. From bottom to top, they are the transitional member, the quartzite member, the lower carbonate-bearing member, the siltstone member, the upper carbonate-bearing member, and the Rainstorm Member. These members are widespread in the southern Death Valley–Kingston Range area, and some of them have been recognized previously by Wright and Troxel (1966). Only the uppermost member (Rainstorm Member) persists outside the southern Death Valley–Kingston Range area.

TABLE 3.—*Thickness, in feet, of Johnnie Formation and its members*

[Symbols used: nr = not recognized; nm = not measured; ne = not exposed; 0 = absent]

Locality	Locality No. (fig. 2)	Johnnie Formation (* incomplete)	Transitional member	Quartzite member (* incomplete)	Lower carbonate-bearing member	Siltstone member	Upper carbonate-bearing member (* incomplete)	Rainstorm Member [1]
Providence Mountains	41	113	nr	nr	nr	nr	nr	nr
Northwestern part of Clark Mountains	36	422	157±		47	140±		78?
Silurian Hills	35	835	195	185	110	70	234	41
Silver Lake	38	* 153	ne	ne	ne	ne	* 85±	68±
Winters Pass	32	nm	nm	nm	nm	nm	nm	100±
Old Dad Mountain	39	* 531	ne	* 75	90	55	124	187±
Salt Spring Hills No. 2	34	898	180±	170	83	123	180	162
Winters Pass Hills	31	1, 246	170	183	85	308	228	272
Ibex Pass	30	nm	nm	nm	nm	nm	nm	307
Middle part of Kingston Range	29	nm	nm	nm	nm	nm	nm	357
Western part of Kingston Range	28	nm	nm	nm	nm	nm	nm	383
Arrastre Spring	19	nm	nm	nm	nm	nm	nm	486±
Six Spring-Johnson Canyons	18	1, 794	331	155	8	345±	360±	595
Black Mountain	23	1, 864	200	347±	55	300±	413	549
Hanaupah Canyon	16	2, 317±	320±	247±	177±	650±		923±
Rogers Peak	15	* 762	401	179	nr	nr	nr	nr
Nopah Range	26	2, 550	485	480	25	585	590	385
Indian Pass	10	2, 994(?)	nr	nr	nr	nr	nr	nr
Johnnie Wash	61	* 4, 460	nr	nr	nr	nr	nr	875
Desert Range	70	* 5, 218	nr	nr	nr	nr	nr	936
Halfpint Range	56	* 1, 900	ne or nr	ne or nr	ne or nr	ne or nr	ne or nr	1, 025
Northern part of Resting Spring Range	21	* 1, 395	ne or nr	ne or nr	ne or nr	ne or nr	ne or nr	1, 136

[1] Thickness of units in Rainstorm Member:

Locality	Locality No. (fig. 2)	Rainstorm Member	Units in Rainstorm Member: Siltstone unit. Thicknesses in parentheses indicate position of Johnnie oolite, where present, above base of unit. op = oolite present, but position not given	Units in Rainstorm Member: Carbonate unit	Units in Rainstorm Member: Siltstone and quartzite unit
Providence Mountains	41	nr	nr	nr	nr
Northwestern part of Clark Mountains	36	78	0	65	13
Silurian Hills	35	41	41 (8– 13)	0	0
Silver Lake	38	68±	40±	28	0
Winters Pass	32	100±	45± (5– 7?)	55±	0
Old Dad Mountain	39	187±	177± (16– 27)	10	0
Salt Spring Hills No. 2	34	162	87 (15– 21)	75	0
Winters Pass Hills	31	272	85 (38– 45)	150	37
Ibex Pass	30	307	105 (39– 44)	147	55
Middle part of Kingston Range	29	357	107 (48– 57)	165	85
Western part of Kingston Range	28	383	70 (30– 38)	170	143
Arrastre Spring	19	486±	26? (23– 26)	250	210±
Six Spring-Johnson Canyons	18	595	48 (30– 34)	157	390
Black Mountain	23	549	84 (32– 39)	165	300
Hanaupah Canyon	16	923±	nr	280±	643±
Rogers Peak	15	nr	nr	nr	nr
Nopah Range	26	385	63 (45– 55)	124	198
Indian Pass	10	nr	nr	nr	nr
Johnnie Wash	61	875	95 (45–65?)	270	510
Desert Range	70	936	76 (70– 76)	650	210
Halfpint Range	56	1, 025	op 935		335
Northern part of Resting Spring Range	21	1, 136	op nr	nr	nr

TRANSITIONAL MEMBER

The transitional member contains a mixture of lithologic types, some of which are similar to the underlying Noonday Dolomite and some of which resemble the overlying part of the Johnnie Formation. The dominant types are medium-gray very finely crystalline dolomite and sandy dolomite, which weather to very pale orange. They are laminated to thinly bedded and are locally cross-stratified. The sandy dolomite contains fine to very coarse grains of quartz, and in some places both the dolomite and the sandy dolomite contain scattered pebbles (up to 15 mm in diameter) and granules of quartz; pebbles and granules of quartzite and chert are rare. Concretionary algal structures are found in the dolomite in Six Spring Canyon (loc. 18) and Hanaupah Canyon (loc. 16).

Quartzite, siltstone, shale, and argillite are interstratified with the dolomite and sandy dolomite and amount to about 25 percent of the member. The quartzite, which occurs in layers from less than a foot to several tens of feet thick, is commonly yellow gray, fine to coarse grained, and laminated to very thin bedded. In places it contains scattered granules and small pebbles of quartz and rarely of quartzite and chert. In a few places, small-scale low-angle cross-strata are found. The siltstone, the shale, and the argillite are greenish gray, yellow gray, dark yellowish brown, or dark gray, and are very fine textured. Layers of these very fine textured strata are commonly less than a foot to a few feet thick, although thicker layers also occur.

Measured thicknesses of the transitional member range from 170 to 485 feet (table 3).

In the Panamint Range, the correlation of the transitional member and other membes of the Johnnie between Hanaupah Canyon (fig. 4, loc. 16) and Rogers Peak (loc. 15) cannot be determined. Here the Noonday Dolomite and the Johnnie Formation are lithologically similar, and the contact between them is uncertain. Resolution of this correlation will depend on detailed mapping of units in the Noonday and Johnnie northward in the Panamint Range.

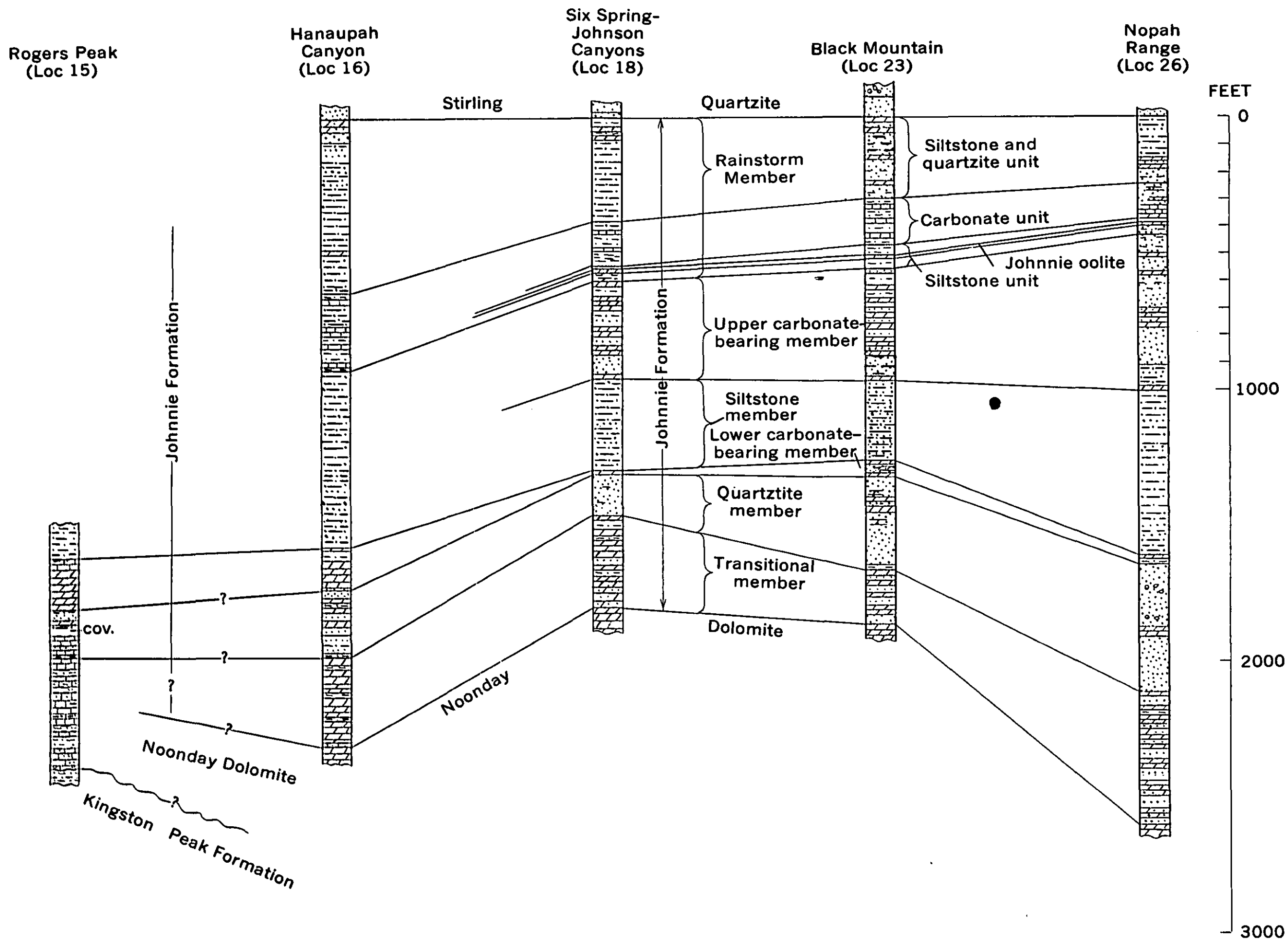


FIGURE 4.—Correlation of the Johnnie Formation from Rogers Peak in the Panamint Range to the southernmost areas of outcrop in the Nopah Range, Calif.

QUARTZITE MEMBER

The dominant lithologic type in the quartzite member is yellowish-gray, pale-yellowish-brown, or pinkish-gray fine- to coarse-grained quartzite. In places, the quartzite is very coarse grained or conglomeratic and contains granules and small pebbles of quartz. Small-scale low-angle cross-strata, mostly of the tabular planar type, are common in the quartzite. On the basis of two studies of dip directions of cross-strata (table 2; fig. 3), current directions during deposition of the quartzite member were determined to be to the southwest. The member contains minor amounts of dolomitic sandstone, dolomite, and siltstone at some localities. The amount of carbonate in the unit appears to increase northward in the Panamint Range from a very minor amount at Six Spring Canyon to a sizable amount at Hanaupah Canyon, 10 miles to the north (fig. 4). At Rogers Peak, 4 miles northwest of Hanaupah Canyon, a unit that is questionably correlated with the quartzite member consists of limestone, sandy limestone, and minor amounts of quartzite and phyllite (fig. 4).

The quartzite member where typically developed forms a conspicuous ledge or cliff and is one of the most easily recognized parts of the Johnnie Formation.

The quartzite member ranges in thickness from 155 feet to 480 feet (table 3).

LOWER CARBONATE-BEARING MEMBER

The lower carbonate-bearing member is a poorly defined and laterally variable unit characterized by carbonate layers. At the Six Spring–Johnson Canyons section (fig. 4, loc. 18), it consists of a single medium-gray very finely crystalline laminated to thin-bedded dolomite about 8 feet thick. At the Nopah Range section (fig. 4, loc. 26), it is also thin and consists of an inconspicuous 10-foot dolomite and an underlying 15-foot unit of sandstone and shale. In most other areas the member commonly consists of light-gray, olive-gray, and pale-yellowish-brown dolomite and sandy dolomite and minor amounts of quartzite, dolomitic sandstone and siltstone and is about 100 feet thick or less. At Hanaupah Canyon in the Panamint Range, however, the member is 177 feet thick and contains a 110-foot unit of light-medium-gray massive dolomite that is virtually indistinguishable from dolomite in the Noonday Dolomite. An even thicker unit of lithologically similar dolomite occurs at Rogers Peak, farther north in the Panamint Range, and this unit is tentatively correlated with part of the lower carbonate-bearing member. The lower carbonate-bearing member appears to be a persistent interval of carbonate strata in the Johnnie Formation, but the lateral differences in the thickness and the lithologic character of the unit suggest a complex depositional history.

SILTSTONE MEMBER

The siltstone member ranges in thickness from less than 100 feet to almost 600 feet and consists predominantly of slope-forming siltstone and either sandstone or quartzite. The siltstone, which is composed of fine to coarse silt, is moderate yellowish brown, light greenish gray, or yellowish gray, micaceous, and platy. In some parts of the region the siltstone has been metamorphosed to phyllitic siltstone or argillite. Interstratified sandstone (or locally quartzite), which occurs as layers a few inches thick, is pale to dark yellowish brown, very fine grained, micaceous, laminated to very thin bedded, and commonly platy. The sandstone forms most of the basal 50–100 feet of the member, but decreases in amount upward. It is a minor part of the upper part of the member in most areas, but in a few areas forms as much as 50 percent of this part of the member.

X-ray diffraction work and microscopic study of thin sections show that the siltstone is composed of quartz, muscovite, and a lesser amount of chlorite (table 4). The quartz occurs as subangular grains that are commonly of coarse silt size. The muscovite and chlorite occurs in fibers that are coarse silt sized or smaller. In some specimens, those that have apparently been sheared, the micaceous minerals have a strong preferred orientation.

Parts of the siltstone member have been considered to be tuffaceous. This possibility was first suggested by Hazzard (1937a, p. 304) and was further examined by D. D. McDowell (written commun., 1966), who studied thin sections of tuffaceous-appearing rocks that crop out in the Panamint Range in the lower 200–300 feet of what is called here the siltstone member. Some of these tuffaceous-appearing rocks are composed entirely of quartz, muscovite, and minor amounts of feldspar and are similar in composition and texture to altered felsic tuffaceous sediments described by Pirsson (1915). Wright and Troxel (1966, p. 853 and fig. 2) have also suggested that volcanic ash may occur in the Johnnie Formation; the bed that is possibly volcanic ash according to these geologists appears to be within the upper carbonate-bearing member and is apparently not correlative with the possibly tuffaceous unit in the Panamint Range. They found relict outlines of fragments that are in part shardlike and that in part resemble phenocrysts of feldspar. Nonetheless, no definitely identifiable grains of volcanic rock have been observed, as far as the writer knows, in any of these supposedly tuffaceous rocks.

To further test for the possibility of tuffaceous material in the siltstone member, as well as in other formations of the upper Precambrian and Lower Cambrian sequence in the southern Great Basin, nine chemical analyses of siltstone and argillite from the siltstone member and 35 analyses from siltstone, argillite, and phyllite from other units in the upper

Precambrian and Lower Cambrian sequence were made (table 4). Four of these samples (DV170A, CP310, CP23b, and CP65) were kindly supplied by D. D. McDowell from the possibly tuffaceous units he had studied in the Panamint Range. The field of these siltstones, when plotted on commonly used ternary diagrams (fig. 5), is consistently different from that of unaltered igneous rocks ranging in composition from rhyolite to basaltic andesite. The results from the chemical analyses seem to be inconclusive, however, because the tuffaceous material could be highly altered and thus unrecognizable by chemical means, or the amount of tuffaceous material could be so low that it is undetectable.

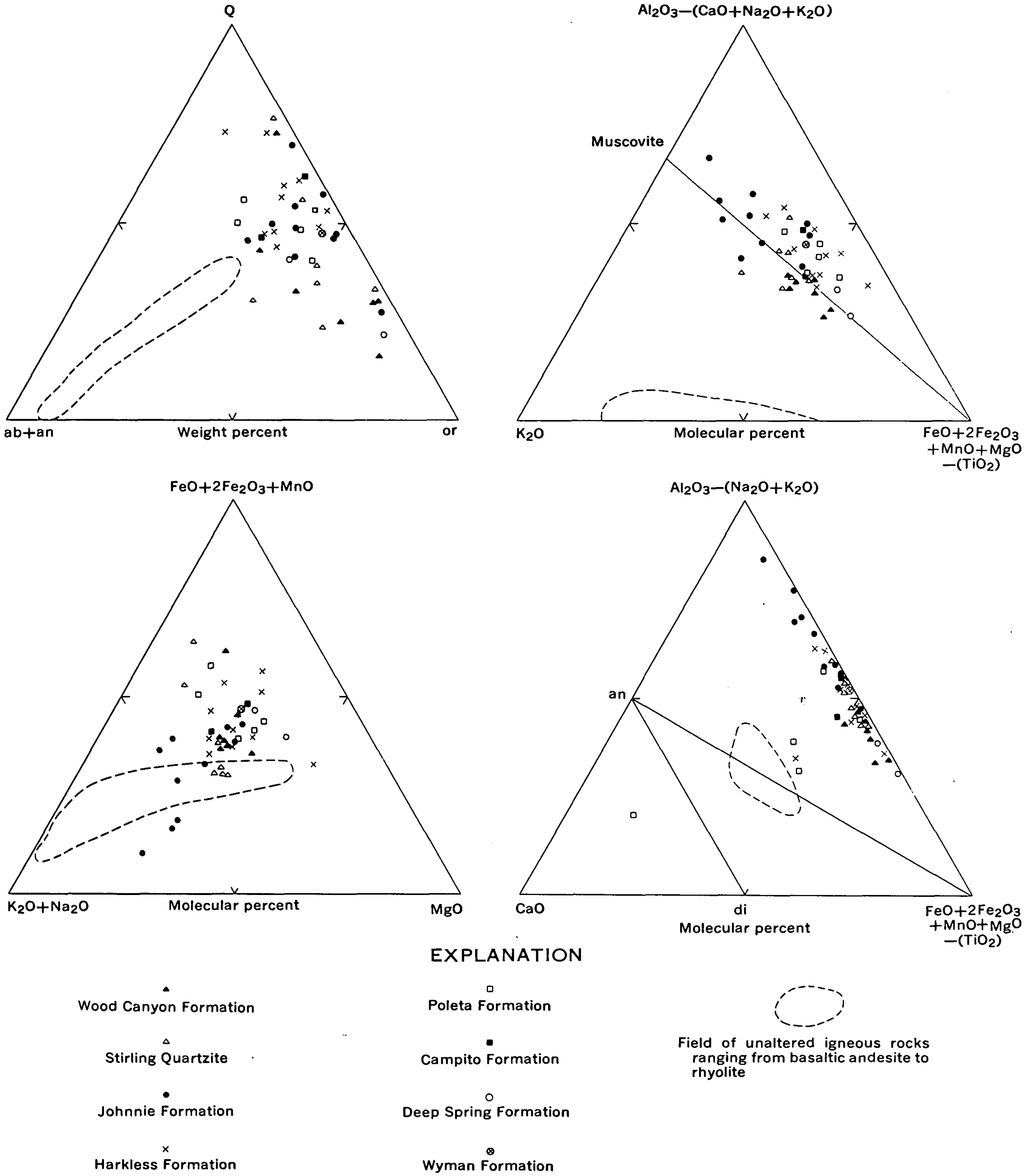


FIGURE 5.—Ternary diagrams showing variation in composition of 44 pelitic rocks and comparison of their field with that of unaltered igneous rocks ranging in composition from basaltic andesite to rhyolite.

TABLE 4.—*Chemical and modal characteristics of*

[Rapid rock analysis: P. L. D. Elmore, Gillison Chloe, S. D. Botts, Lowell Artis, Hezekiah Smith, Dennis Taylor, and J. L. Glenn. Methods
analysis: six-step analysis by Chris Heropoulos; symbols used: 0=looked for but not detected; dashes (--)=not looked for; < =with
1, 0.7, 0.5, 0.3, 0.2, 0.15, and 0.1,. . . ; which represent approximate midpoints of interval data on a geometric scale. The assigned interval
Hf, Hg, In, Li, Mo, Pd, Pt, Re, Sb, Sn, Ta, Te, Th, Tl, U, W, and Zn; Pr, Sm, and Eu looked for but not detected in samples containing
tion: Rough estimates of mineral percentages based on X-ray diffraction patterns and chemical analyses; symbols used: tr.=trace;

Region	Western						
Formation	Harkless Formation						
Member	Siltstone member				Quartzitic siltstone member	Undifferentiated	
Laboratory No[2]	165802 65M-1198	165803 65M-1199	165804 65M-1200	165807 65M-1203	165801 65M-1197	165815 65M-1211	165816 65M-1212
Field No	JS-61-63	JS-61-64	JS-61-65B	JS-62-29	JS-61-57	JS-63-24	JS-63-26
Locality No. (fig. 2) or location	(3)	(3)	(3)	(4)	8	5	5
							Rapid rock
SiO_2	69.0	64.0	62.4	64.8	59.8	55.4	66.4
Al_2O_3	12.9	16.9	20.9	16.0	16.5	21.4	18.8
Fe_2O_3	2.1	1.4	2.3	2.4	2.2	2.7	1.3
FeO	5.6	6.5	2.9	3.0	3.3	6.2	2.7
MgO	2.7	2.2	1.3	2.6	2.4	2.9	1.4
CaO	.15	.42	.32	.80	3.5	.45	.40
Na_2O	1.1	.20	.55	.40	1.2	.00	.05
K_2O	1.4	2.3	3.6	3.8	4.1	4.0	4.3
H_2O^-	.18	.10	.30	.55	.14	.44	.05
H_2O^+	3.3	4.2	3.7	3.6	2.9	4.6	3.2
TiO_2	.67	.79	.73	.75	.73	.84	1.1
P_2O_5	.08	.11	.12	.11	.09	.16	.06
MnO	.05	.13	.00	.00	.03	.16	.00
CO_2	.18	.18	.06	.31	2.5	.06	.12
Sum	99	99	99	99	99	99	100
							Semiquantitative
Ag	0	0	0	0	0	0	0
B	.005	.007	.015	.005	.007	.01	.02
Ba	.03	.05	.07	.07	.1	.05	.05
Be	0	.0001	.0002	.0002	.00015	.00015	.0002
Ce	0	.015	.015	.015	.02	.015	0
Co	.002	.003	.001	.002	.002	.002	.002
Cr	.007	.01	.01	.01	.01	.015	.01
Cu	.005	.005	.003	.003	.0015	.003	.002
Ga	.001	.002	.002	.0015	.0015	.002	.0015
La	.003	.007	.01	.005	.007	.007	.003
Nb	.002	.0015	.002	.0015	.0015	.002	.002
Nd[12]	0	0	0	0	0	0	0
Ni	.007	.01	.007	.007	.007	.01	.005
Pb	0	.002	.002	0	0	0	0
Sc	.0015	.002	.003	.0015	.002	.002	.002
Sr	.002	.005	.01	.002	.003	.005	.003
V	.007	.01	.015	.01	.01	.01	.015
Y	.005	.007	.007	.005	.005	.005	.007
Yb	.0005	.0007	.0005	.0005	.0005	.0005	.0007
Zr	.03	.03	.02	.03	.03	.02	.07
							Mineral
Quartz	50	45	40	40	30	25	40
Muscovite	12	20	35		40	30	35
Mica clay				30			
Chlorite	20	30	12	20	20	40	20
K-feldspar			(?)				
Plagioclase	5						
Calcite		tr.		tr.	4		
Pyrophyllite or talc							
Biotite							
Amorphous iron material	(?)						

[1] In strata possibly equivalent to Reed Dolomite.
[2] Where two numbers shown, upper number indicates that for rapid rock analysis and lower number that for semiquantitative spectrographic analysis.
[3] Sec. 6, T. 2 S., R. 41 E.
[4] Sec. 34, T. 2 S., R. 41 E.
[5] Sec. 19, T. 5 S., R. 41 E.
[6] Sec. 32, T. 21 N., R. 6 E.

upper Precambrian and Lower Cambrian pelitic rocks

similar to those described in U.S. Geol. Survey Bull. 1144–A modified to use the atomic absorption technique. Semiquantitative spectrographic number, less than number shown, here usual detectabilities do not apply; results are reported in percent to the nearest number in the series for semiquantitative results will include the quantitative value about 30 percent of the time. Looked for but not detected: As, Au, Bi, Cd, Ge, La or Ce; Gd, Tb, Dy, Ho, Er, Tm, and Lu looked for but not detected in samples containing more than 0.005 percent Y. Mineral composi- ? =probably present; > = probably greater than amount indicated; <=probably less than amount indicated; dashes (--)=not detected]

Western—Continued												
Harkless Formation—Continued			Poleta Formation					Campito Formation		Deep Spring Formation		Wyman Formation
Undifferentiated—Continued			Middle member				Lower member	Montenegro Member		Upper member	Lower member [1]	----------
165819 65M-1215	165820 65M-1216	165821 65M-1217	165805 65M-1201	165806 65M-1202	165809 65M-1205	165818 65M-1214	165808 65M-1204	165810 65M-1206	165811 65M-1207	165822 65M-1218	165817 65M-1213	165800 65M-1196
JS-63-40	JS-63-55	JS-63-56	JS-62-4	JS-62-15	JS-62-33	JS-63-38	JS-62-32	JS-62-39	JS-62-48	JS-63-66	JS-63-31	JS-61-49
4	1	1	52	([8])	45	4	45	45	45	5	6	51
analysis												
59.5	64.6	54.8	58.3	54.2	61.2	59.8	41.8	60.9	64.8	59.1	47.8	56.5
20.5	18.1	23.6	20.8	18.8	14.8	19.5	14.0	20.1	17.3	15.8	23.0	22.0
3.2	2.1	2.6	6.0	3.3	1.5	3.1	4.2	2.7	2.0	5.0	3.3	2.9
2.8	2.6	5.9	.66	3.3	4.5	3.6	1.4	3.6	3.6	5.0	6.5	4.4
2.3	1.9	1.8	1.1	2.8	2.7	2.8	.82	2.0	1.8	3.6	5.5	2.4
.45	.25	.30	.85	4.2	4.0	.55	17.8	.40	1.1	.38	.50	.31
.20	1.3	1.1	.38	.15	1.3	.71	.72	.00	1.2	1.1	.10	.32
4.9	4.2	3.3	4.5	3.8	2.6	5.2	2.0	3.8	4.1	4.2	5.6	4.6
.34	.09	.20	.20	.84	.12	.21	.23	.40	.15	.37	.47	.54
3.9	3.0	4.9	5.1	4.3	3.2	3.3	2.6	4.3	2.7	3.0	5.1	4.2
.79	.88	.88	.84	.73	.70	.92	.54	.88	.82	1.5	1.2	.81
.09	.09	.11	.15	.11	.18	.15	.11	.14	.14	.20	.13	.11
.04	.00	.07	.00	.06	.06	.03	.08	.05	.04	.03	.02	.08
.10	.07	.10	.30	2.8	2.9	.17	13.1	.18	.18	.12	.12	.12
99	99	100	99	99	100	100	99	99	100	99	99	99
spectrographic analysis												
0	0	0	0	0	0	0	0	0	0	0	0	0
.015	.01	.007	.01	.005	.01	.01	.005	.015	.007	.005	.005	.007
.03	.07	.07	.05	.07	.05	.07	.05	.05	.05	.05	.07	.1
.0002	.00015	.0003	.0003	.0002	.0001	.0003	.00015	.0002	.0003	0	.0002	.0002
0	0	.015	.02	.015	0	.015	0	0	.015	0	.015	.015
.0015	.0015	.003	.0015	.003	.002	.002	.001	.002	.002	.0007	.002	.003
.015	.01	.015	.015	.015	.01	.015	.01	.01	.007	.01	.015	.015
.0015	.0015	.003	.007	.005	.0015	.003	.003	.002	.003	.015	.01	.005
.002	.0015	.003	.002	.002	.0015	.002	.0015	.002	.0015	.0015	.003	.003
.005	.007	.01	.01	.007	.005	.007	.007	.007	.007	.007	.007	.01
.002	.002	.003	.0015	.002	.0015	.003	.001	.003	.002	.002	.003	.005
0	0	.007	0	0	0	0	0	0	0	.007	0	.007
.007	.007	.007	.007	.007	.007	.007	.005	.007	.005	.01	.007	.007
0	0	.0015	.0015	0	.0015	.001	.0015	0	.0015	.002	.001	0
.002	.002	.003	.003	.002	.0015	.002	.003	.002	.0015	.002	.003	.003
.003	.002	.01	.01	.005	.01	.007	.05	.01	.005	.003	.003	.007
.01	.01	.01	.015	.01	.007	.015	.01	.015	.01	.02	.015	.015
.005	.005	.005	.005	.005	.003	.007	.005	.005	.003	.005	.005	.007
.0005	.0005	.0005	.0005	.0005	.0003	.0005	.0005	.0005	.0003	.0005	.0005	.000
.03	.05	.015	.02	.015	.03	.03	.015	.02	.02	.02	.03	.0155
composition												
>25	40	25	25	25	30	25	20	40	35	30	10	25
40	35	25	--	--	15-20	>40	20	30	30	15	40	40
--	--	--	40	30	--	--	--	--	--	--	--	--
<20	15	40	--	15	25	20	15	20	20	>5	45	30
--	--	(?)	--	--	--	--	--	(?)	--	--	--	--
--	<10	--	--	--	10	(?)	--	--	10	--	--	--
--	--	--	<1	5	5	--	25	--	tr.	--	--	--
--	--	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	40	--	--
--	--	--	(?)	(?)	--	--	--	--	--	--	--	--

[7] Sec. 20, T. 21 N., R. 46 E.
[8] Lat 36°03′, long 117°04′.
[9] Lat 36°22′, long 117°06′.
[10] Lat 36°03′, long 117°04′.
[11] Lat 36°01′, long 117°04′.
[12] Looked for only when La or Ce found.

TABLE 4.—*Chemical and modal characteristics of*

[Rapid rock analysis: P. L. D. Elmore, Gillison Chloe, S. D. Botts, Lowell Artis, Hezekiah Smith, Dennis Taylor, and J. L. Glenn. Methods graphic analysis: six-step analysis by Chris Heropoulos; symbols used: 0=looked for but not detected; dashes (__)=not looked for; the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, and 0.1, . . .; which represent approximate midpoints of interval data on a geometric scale. The As, Au, Bi, Cd, Ge, Hf, Hg, In, Li, Mo, Pd, Pt, Re, Sb, Sn, Ta, Te, Th, Tl, U, W, and Zn; Pr, Sm, and Eu looked for but not detected Y. Mineral composition: Rough estimates of mineral percentages based on X-ray diffraction patterns and chemical analyses; symbols (__)=not detected]

Region	Central								
Formation	Wood Canyon Formation							Stirling Quartzite	
Member	Upper member				Middle member	Lower member		E member	
Laboratory No[2]	165813 65M-1209	165814 65M-1210	165824 65M-1220	165838 65M-1234	165832 65M-1228	165825 65M-1221	165837 65M-1233	165830 65M-1226	165831 65M-1227
Field No	JS-63-11A	JS-63-20	JS-63-92A	JS-65-22	JS-65-3	JS-63-130	JS-65-19	JS-64-133	JS-64-136
Locality No. (fig. 2) or location	7	7	66	14	([6])	26	14	57	57
									Rapid rock
SiO_2	52.7	58.5	76.9	57.0	51.9	61.8	55.5	60.9	57.7
Al_2O_3	23.5	20.1	9.0	20.2	17.8	17.0	20.8	19.1	21.2
Fe_2O_3	1.9	3.6	3.0	4.6	13.6	2.3	2.5	4.1	3.5
FeO	5.1	3.0	1.7	2.3	1.2	3.8	4.7	.90	2.0
MgO	3.0	2.8	1.5	2.6	2.1	3.3	2.9	2.9	3.1
CaO	.32	.60	.90	.68	.72	.55	.45	.63	.52
Na_2O	.55	1.2	.10	.00	.00	.75	.85	.04	1.2
K_2O	7.7	5.3	3.2	7.3	6.0	5.0	6.6	7.3	6.6
H_2O^-	.15	.16	.24	.26	.25	.45	.25	.08	.10
H_2O^+	3.3	3.4	1.9	3.3	2.6	3.4	3.1	2.1	2.6
TiO_2	.97	.79	.23	.92	2.5	1.3	1.5	.91	.26
P_2O_5	.11	.08	.40	.14	.36	.15	.15	.12	.12
MnO	.08	.03	.00	.00	.00	.00	.03	.02	.00
CO_2	.16	.13	07	.17	.11	.07	.06	.15	.12
Sum	100	100	99	99	99	100	99	99	99
									Semiquantitative
Ag	0	0	0	0	0	0	0	0	0
B	.007	.01	.005	.015	.007	.005	.005	.005	.003
Ba	.15	.1	.07	.07	.07	.1	.07	.1	.15
Be	.0003	.0002	0	.0005	.0005	.00015	.00015	.0002	.0002
Ce	.02	.015	0	.015	0	.015	0	.02	.02
Co	.002	.0015	.001	.0015	.002	.003	.003	.0015	.003
Cr	.015	.015	.002	.01	.01	.015	.015	.015	.015
Cu	.0015	.005	.0015	.0007	.007	.003	.007	.001	.003
Ga	.002	.002	.001	.002	.002	.0015	.003	.002	.003
La	.015	.01	.005	.01	.003	.007	.005	.01	.01
Nb	.003	.002	0	.0015	.005	.002	.002	.002	.002
Nd [12]	.01	0	0	0	0	0	0	0	.01
Ni	.005	.007	.005	.005	.007	.01	.005	.005	.005
Pb	0	0	.0015	.001	.002	.0015	0	0	0
Sc	.003	.002	.0007	.003	.005	.002	.003	.002	.002
Sr	.003	.007	.005	.002	.002	.007	.003	.0015	.003
V	.015	.01	.005	.015	.03	.02	.02	.01	.01
Y	.005	.005	.007	.005	.01	.005	.007	.007	.005
Yb	.0005	.0005	.0005	.0005	.001	.0005	.0005	.0005	.0005
Zr	.03	.02	.02	.015	.05	.02	.02	.03	.05
									Mineral
Quartz	10	20	60	<20	20	25	15	20	15
Muscovite	65	40	<10	45	--	20	50	60	>50
Mica clay	--	--	--	--	>20	--	--	--	--
Chlorite	15	<10	5	<15	<10	25	15	--	--
K-feldspar	--	--	20	<10	20	15	--	--	--
Plagioclase	--	--	5	--	--	?	<5	--	?
Calcite	--	--	--	--	--	--	--	--	--
Pyrophyllite or talc	--	--	--	--	--	--	--	--	--
Biotite	--	--	--	--	--	--	--	--	--
Amorphous iron material	--	?	--	--	--	--	--	?	--

See footnotes on p. 22–23.

UPPER CARBONATE-BEARING MEMBER

The upper carbonate-bearing member is a lithologically heterogeneous and laterally variable sequence composed dominantly of dolomite, quartzite, and siltstone. The dolomite, which is the most distinctive feature of the member, is medium gray, yellowish gray, and olive gray on fresh surfaces, but generally weathers moderate yellowish brown or grayish orange. It is aphanitic to very finely crystalline and is laminated to thin bedded; low-angle small-scale cross-strata occur rarely. Irregular layers and lenses of gray chert occur in the dolomite at some localities (loc. 31, unit 11, see strat. sections; loc. 23, unit 14, see sections; loc. 34, unit 6, see sections). The dolomite commonly contains very fine to fine grains of quartz and grades to dolomitic sandstone. The quartzite and the sandstone in the member are yellowish gray to pale yellowish brown, very fine to fine grained, rarely fine to medium grained, and laminated. The siltstone is greenish gray and pale yellowish brown and is commonly *upper Precambrian and Lower Cambrian pelitic rocks*—Continued

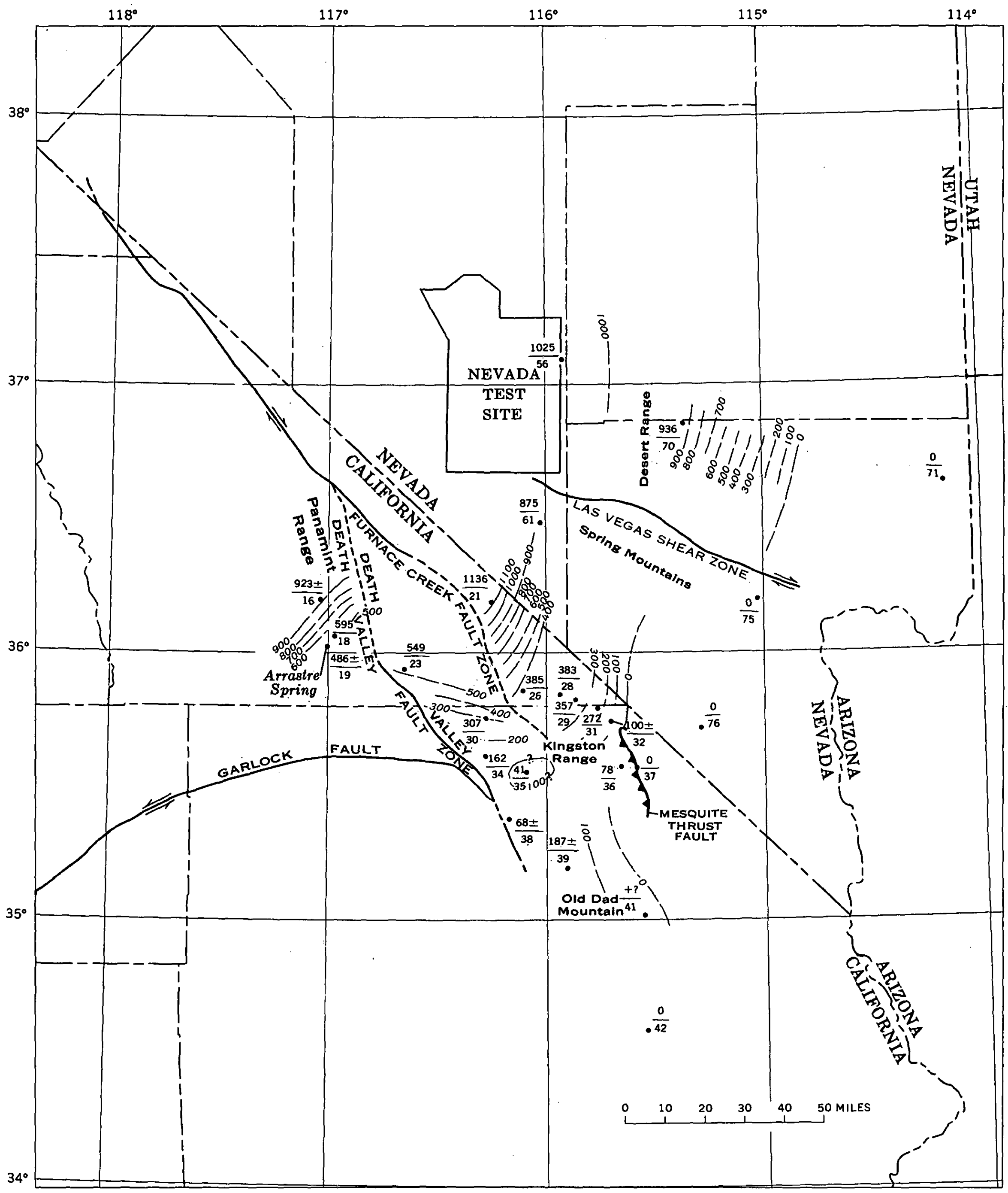
similar to those described in U.S. Geol. Survey Bull. 1144–A modified to use the atomic absorption technique. Semiquantitative spectro-
<=with number, less than number shown, here usual detectabilities do not apply; results are reported in percent to the nearest number in assigned interval for semiquantitative results will include the quantitative value about 30 percent of the time. Looked for but not detected: in samples containing La or Ce; Gd, Tb, Dy, Ho, Er, Tm, and Lu looked for but not detected in samples containing more than 0.005 percent used: tr.=trace; ?=probably present; >=probably greater than amount indicated; <=probably less than amount indicated; dashes

	Central—Continued														
	Stirling Quartzite—Continued					Johnnie Formation									
	C member		B(?) member	A member		Rainstorm Member	Siltstone member					Basal part of siltstone member			
	165823 65M-1219	165827 65M-1223	165829 65M-1225	165812 65M-1208	165826 65M-1222	165828 65M-1224	165833 65M-1229	165834 65M-1230	165835 65M-1231	165836 65M-1232	M100832W	M100833W	M100834W	M100835W	M100836W
	JS-63-82	JS-64-28	JS-64-109	JS-63-7	JS-64-21	JS-64-57	JS-65-5	JS-65-7	JS-65-8	JS-65-14	DV170A	CP310	CP23b	CP65	JS-65-29
	64	54	34	12	54	31	26	26	26	16	(7)	(8)	(9)	(10)	(11)
analysis															
	61.2	61.6	66.5	73.3	54.5	58.1	61.0	63.2	65.9	54.7	77.6	68.6	57.7	63.4	63.1
	19.1	19.0	17.0	14.0	23.2	22.4	22.1	21.1	21.3	23.8	12.7	18.6	22.9	19.4	17.9
	1.4	3.1	2.8	4.9	7.7	3.2	4.5	3.5	.48	1.6	1.1	1.1	1.8	3.9	3.3
	3.7	1.8	1.9	.74	1.1	.96	.20	.22	.22	5.4	.16	.28	4.4	.44	2.5
	2.8	2.5	1.8	.4	1.1	1.7	1.0	.8	.9	2.7	.95	1.2	2.2	1.7	2.4
	.26	.47	.35	.25	.45	.60	.30	.55	.35	.40	.20	.03	.15	.15	.22
	2.4	.75	.38	.10	.00	.00	.20	1.1	.62	.85	.10	.07	1.6	.22	.75
	4.7	5.8	4.6	2.7	6.8	8.4	5.9	4.2	4.8	4.2	4.1	5.5	3.2	6.0	4.6
	.14	.12	.42	.04	.08	.46	.37	.47	.38	.25	.04	.06	.14	.11	.13
	3.1	3.0	2.3	1.9	3.0	3.1	2.5	3.7	3.3	4.9	1.3	2.6	4.6	2.9	3.9
	.86	.75	.73	.88	.92	.75	.91	.94	.91	.88	.73	1.0	.87	1.0	.95
	.08	.11	.07	.12	.19	.11	.06	.04	.02	.07	.05	.13	.13	.09	.18
	.03	.02	.00	.00	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00
	.10	.06	.13	.16	.08	.12	.07	.12	.06	.10	<.05	<.05	<.05	<.05	<.05
	100	99	99	99	99	100	99	100	99	100	99	99	100	99	100
spectrographic analysis															
	0	0	0	0	0	0	0	0	0	0	<.00007	0	<.00007	0	0
	.01	.005	.01	.01	.01	.015	.015	.01	.01	.007	.01	.015	.015	.01	.007
	.07	.07	.07	.03	.07	.07	.07	.07	.07	.05	.07	.1	.03	.1	.07
	.0002	.0002	.0002	.0001	.0005	.0002	.0002	.00015	.00015	.0002	.0003	.0003	.0003	.0003	.0003
	.015	.015	0	0	.015	.015	.015	.015	.015	0	0	0	0	.015	.01
	.002	.0003	.002	.001	.005	.001	.0005	.0002	0	.001	0	0	.001	0	.002
	.01	.015	.01	.007	.01	.01	.01	.01	.01	.01	.005	.01	.01	.01	.01
	.002	.015	.003	.007	.001	.007	.005	.003	.0015	.005	.0005	.0002	.01	.007	.005
	.002	.002	.0015	.0015	.002	.003	.002	.002	.002	.003	.0015	.003	.003	.003	.002
	.01	.007	.003	.005	.01	.01	.01	.007	.007	.007	0	.005	.003	.007	.005
	.003	.0015	.0015	.002	.002	.003	.0015	.0015	.002	.0015	.002	.002	.002	.002	.003
	0	0	0	0	0	.007	0	0	0	0	----------	0	0	0	0
	.005	.005	.005	.005	.015	.007	.002	.001	0	.005	0	.0003	.003	.0007	.007
	.007	0	.003	.005	.001	.0015	.002	.001	0	.0015	.002	.001	.003	0	.0015
	.002	.002	.0015	.0015	.003	.002	.002	.002	.002	.002	.001	.002	.002	.002	.002
	.007	.002	.003	.015	.015	.005	.01	.007	.003	.01	.0015	.002	.03	.0015	.003
	.015	.015	.01	.01	.015	.01	.01	.015	.015	.01	.007	.01	.01	.01	.007
	.003	.005	.005	.007	.007	.007	.005	.005	.003	.003	.003	.005	.003	.003	.007
	.0003	.0005	.0003	.0007	.0007	.0005	.0005	.0005	.0003	.0003	.0003	.0005	.0003	.0003	.0005
	.03	.02	.05	.05	.03	.03	.03	.03	.03	.02	.03	.02	.01	.02	.03
composition															
	>20	35	35	60	20	>15	25	25	35	25	60	45	30	25	45
	30	40	15	30	55	----------	<50	35	35	35	35	50	30	50	40
	----------	----------	----------	----------	----------	>50	----------	----------	----------	----------	----------	----------	----------	----------	----------
	15	15	----------	<10	10	5	<10	10	10	30	----------	----------	35	10	10
	----------	----------	15	tr.	----------	<10	----------	----------	----------	?	----------	----------	----------	----------	----------
	>20	?	----------	----------	----------	----------	----------	10	?	----------	----------	----------	----------	----------	----------
	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
	----------	----------	----------	5	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
	----------	----------	20	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
	----------	----------	----------	----------	?	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------

micaceous and platy. Dolomite, quartzite, and siltstone occur in about equal proportions in the member at many localities and are interstratified in layers from a few inches to about 50 feet thick. At some places, however, dolomite constitutes only about 10 percent of the member. The upper carbonate-bearing member typically weathers to form a ledgy light-colored part of the Johnnie Formation.

An important facies change occurs in the upper carbonate-bearing member in the Panamint Range between Six Spring–Johnson Canyons (loc. 18) and Hanaupah Canyon (loc. 16), about 10 miles farther north. The dolomite, the sandstone, and the quartzite in the member grade out to the north in this area (fig. 4); so at Hanaupah Canyon the strata in the presumed stratigraphic position of the upper carbonate-bearing member are composed entirely of fine-textured phyllite (loc. 16, unit 16, see strat. sections).

The upper carbonate-bearing member ranges in thickness from less than 200 feet to almost 600 feet (table 3).



EXPLANATION

549 / 23   +? / 41

Measured section

Upper number indicates thickness in feet; lower number indicates locality listed in figure 2; plus sign indicates unknown thickness.

?——800

Isopach

Contour interval 100 feet. Queried where uncertain

Strike-slip fault or shear zone

Dashed where inferred. Arrows indicate relative movement

Thrust fault

Sawteeth on upper plate

FIGURE 6.—Isopach map of the Rainstorm Member of the Johnnie Formation.

RAINSTORM MEMBER

The Rainstorm Member (named by Barnes and others, 1965) is the most widespread of the members in the Johnnie Formation. It occurs throughout the southern Death Valley–Kingston Range area, California, as well as in the northwestern part of the Spring Mountains (the type section of the Johnnie Formation), in the Nevada Test Site (the type section of the Rainstorm Member), and in the Desert Range, Nev. (fig. 6). The description given here is for the southern Death Valley–Kingston Range area, although the regional characteristics of the member are so constant that the description also applies to the member elsewhere in the southern Great Basin.

Three units of regional extent are recognized in the Rainstorm Member. These are referred to informally from bottom to top as the siltstone unit, the carbonate unit, and the siltstone and quartzite unit.

The siltstone unit is thin, rarely more than 100 feet thick, and is composed dominantly of greenish-gray, medium-gray, moderate-yellowish-brown, and grayish-red fine- to coarse-textured platy siltstone. In places, minor amounts of very fine grained sandstone occur. A very distinctive grayish-orange oolitic dolomite layer (so-called Johnnie oolite), which is generally 6–12 feet thick, occurs near the middle or in the upper half of the siltstone unit. This layer is composed of oolites ranging from 0.3 to 1 millimeter in diameter (fig. 7) set in a very finely crystalline matrix. The oolite layer occurs above a conspicuous 10–45-foot layer of fine-textured platy siltstone or shale that is in most places slightly purple and glistens or shimmers in bright sunlight.

The carbonate unit consists of pale-red to grayish-red siltstone and limy siltstone and also of pale-red limestone, all of which characteristically have a purplish cast. The rock types are intergradational, and some rocks composed dominantly of carbonate minerals are difficult to distinguish from those composed dominantly of quartz and clay minerals. The strata are laminated to very thin bedded and ripple laminated; most of the limestone is conspicuously laminated. Bedding plane markings such as ripple marks, possible flute casts (fig. 8), and drag marks(?) are abundant in the siltstone. Some of these markings, such as the possible flute casts, have not been noted in any other upper Precambrian and Lower Cambrian unit in the southern Great Basin.

The carbonate unit, with the lithologic characteristics described above, occurs in the Panamint Range (locs. 16, 18, 19) and in the areas between Death Valley and the western part of the Kingston Range (locs. 23, 26, 28, 30), but south of these areas (locs. 29, 31, 32, 34, 38, 39) it is composed dominantly of dolomite instead of siltstone, limy siltstone, and limestone. The contrast between the limy facies to the north and the dolomitic facies to the south is marked, but the correlation seems to be established by the similar stratigraphic positions of the limy and the dolomitic facies in relation to the Johnnie oolite (fig. 4) and by the occurrence in some areas (locs. 29, 30) of stratigraphic sections with lithologic characteristics intermediate between the two facies.

The dolomite of the dolomitic facies of the carbonate unit is very pale orange to grayish orange, very finely crystalline, and laminated to thin bedded. The dolomite forms a conspicuous light-colored ledgy sequence near the top of the Johnnie Formation. Some sandstone, quartzite, dolomitic sandstone, and siltstone are interstratified with the dolomite.

The carbonate unit of the Rainstorm Member is generally about 150–250 feet thick (table 3). The southern dolomitic facies of the unit, however, is commonly thinner.

The siltstone and quartzite unit, the highest unit in the Rainstorm Member, is composed dominantly of greenish-

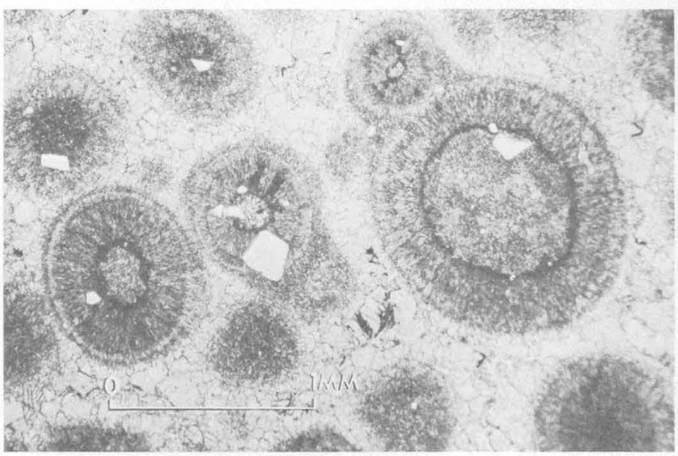


FIGURE 7.—Photomicrograph of the Johnnie oolite. Oolites of dolomite set in dolomite matrix. A few angular grains of plagioclase and quartz(?). Sample JS–64–127, loc. 23. Plane light.

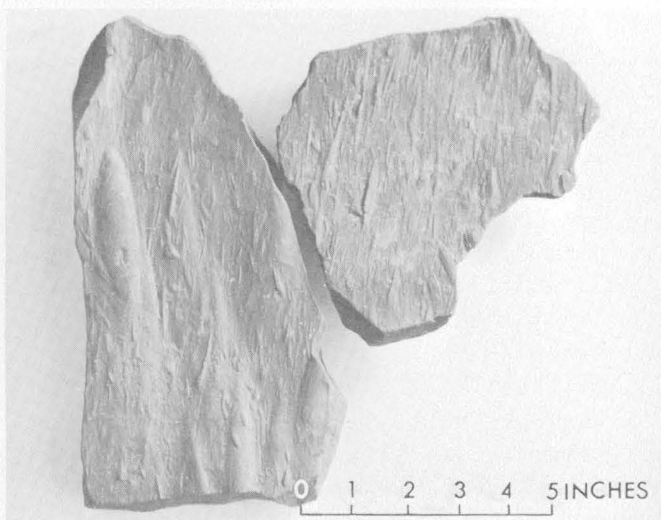


FIGURE 8.—Possible flute casts and other markings on the undersurface of siltstone specimens from the carbonate unit in the Rainstorm Member of the Johnnie Formation, Arrastre Spring (loc. 19), Panamint Range, Calif.

gray and light-olive-gray fine- to coarse-textured siltstone and yellowish-gray and light-greenish-gray laminated to very thin bedded very fine grained micaceous sandstone. Brown-weathering dolomite occurs in the unit in some areas and is common in the top 100 feet or less of the member. In an unusual occurrence in the Panamint Range (Hunt and Mabey, 1966, p. A19), the top 200 feet or so of this unit is dolomite. The siltstone and quartzite unit ranges in thickness from less than 50 feet to more than 600 feet (table 3).

SPRING MOUNTAINS AREA, NEVADA

About 4,500 feet of the Johnnie Formation is exposed (Nolan, 1929, p. 461–663; Burchfiel, 1964, p. 42–43) in the northwestern part of the Spring Mountains at or near its type locality of Johnnie Wash. The stratigraphic sequence here can be divided grossly into three units (pl. 2). The lower unit is about 2,700 feet thick and consists mostly of olive-gray and yellowish-gray siltstone and phyllitic siltstone and minor amounts of yellowish-gray very fine to fine-grained quartzite. A few thin dolomite layers occur in the lower part of this sequence, and a prominent 60-foot dolomite containing layers of chert occurs about 250 feet below the top. The lower unit in the Spring Mountains is apparently correlative with the lower part of the Johnnie as recognized in the southern Death Valley–Kingston Range area. In detail the correlation is uncertain; however, the chert-bearing dolomite may occur in the same general stratigraphic position as similar chert-bearing dolomite layers in the upper carbonate-bearing member in the southern Death Valley–Kingston Range area.

The middle unit in the Spring Mountains area is about 800 feet thick and consists of light-gray fine- to medium-grained quartzite (rarely conglomeratic), minor amounts of brown phyllitic siltstone, and several conspicuous brown dolomite layers that may be as much as 90 feet thick. This unit in the Johnnie appears to be correlative with part of the upper carbonate-bearing member in the southern Death Valley-Kingston Peak area, although the two units differ in the amount of carbonate strata they contain; furthermore, they differ because quartzite in the upper carbonate-bearing unit is mostly very fine to fine grained, whereas in the middle unit at Johnnie Wash it is mostly fine- to medium-grained. Some fine- to medium-grained quartzite layers do occur, however, in the upper carbonate-bearing member in the Nopah Range (loc. 26).

The upper unit in the Spring Mountains area has the same lithology and stratigraphic position as the Rainstorm Member and is referred to by that name here. The Rainstorm Member in Johnnie Wash is about 875 feet thick and contains the same subunits (siltstone unit, carbonate unit, and siltstone and quartzite unit) described previously for the southern Death Valley–Kingston Range area.

DESERT RANGE AREA, NEVADA

About 5,200 feet of the Johnnie Formation is exposed in the Desert Range (Stewart and Barnes, 1966). In this area, five members (pl. 2) have been described, from bottom to top, as follows: (1) a carbonate member, 420 feet thick, consisting of limestone, sandy limestone, fine- to medium-grained quartzite, and scarce dolomite, (2) a lower quartzite and siltstone member, 1,645 feet thick, consisting of fine- to medium-grained quartzite and minor amounts of siltstone, (3) a siltstone and carbonate member, 785 feet thick, consisting of siltstone, some very fine grained sandstone, and two conspicuous carbonate units, the upper one of which contains chert nodules, (4) an upper quartzite and siltstone member, 1,435 feet thick, consisting mostly of fine- to medium-grained locally conglomeratic quartzite and minor amounts of siltstone, and (5) the Rainstorm Member, 936 feet thick, in which the subunits (siltstone unit, carbonate unit, and siltstone and quartzite unit) are the same as those recognized elsewhere in the southern Great Basin.

The lower three members in the Desert Range appear to be correlatives of the lower unit recognized in the Spring Mountains area, although the details of this correlation are uncertain. These members contain abundant fine- to medium-grained quartzite, but the presumably comparable strata in the Spring Mountains contain considerably less quartzite that, moreover, is predominantly fine grained. The chert-bearing dolomite in the siltstone and carbonate member in the Desert Range may be a correlative of a similar chert-bearing dolomite lying about 250 feet below the top of the middle unit in the Spring Mountains area (pl. 2).

The upper quartzite and siltstone member of the Johnnie Formation in the Desert Range seems to be a correlative of the generally similar middle unit in the Spring Mountains area.

The top member in the Desert Range is the Rainstorm Member, which, as already mentioned, has a wide regional extent.

FUNERAL MOUNTAINS AREA, CALIFORNIA

Strata in the Funeral Mountains that are correlated with the Johnnie Formation consist of greenish-gray phyllite or mica schist (metasiltstone) and minor amounts of yellow-gray conglomerate composed dominantly of granules of quartz, although some small pebbles of quartz also occur. The conglomerate occurs in layers that are generally 10–50 feet thick; they appear to be lenses, although the structure in the area is complex and in some places what appears to be lensing could be due to tectonic, rather than sedimentary, causes. The conglomerate is very thin to thick bedded. The strata correlated with the Johnnie are about 3,000 feet thick at the measured stratigraphic section (loc. 10) in the Funeral Mountains, although this thickness is considered to be only a rough estimate because the strata in that area are cut by many faults and are folded. Wright and Troxel (1968) have indicated that the maximum thickness of the Johnnie in the Funeral Mountains is only 1,500 feet.

The strata in the Funeral Mountains are considerably different in lithologic character from the the strata of the Johnnie Formation in most of the southern Great Basin. The extension of the Johnnie into the Funeral Mountains seems to be assured, however, because the strata lie conformably below the Stirling Quartzite and because in nearby areas (for example, the northern part of the Resting Spring Range, loc. 21) the Johnnie Formation contains some granule conglomerate that is similar to the conglomerate that characterizes the formation in the Funeral Mountains.

The Johnnie Formation in the Funeral Mountains is unconformable on the underlying strata, as was shown to me by L. A. Wright and B. W. Troxel (oral commun., 1963). At a locality about three-quarters of a mile east of Chloride Cliff, the unconformity is well exposed and is angular; the strata below the unconformity are at an angle of a few degrees, and locally as much as about 45°, to the overlying strata. Here the basal strata of the Johnnie consist of muscovite-quartz schist containing rounded clasts of quartz, quartzite, schist, and marble, some of which are over 1 foot in diameter. A similar conglomerate occurs farther south in the Funeral Mountains (loc. 10), where about the basal 300 feet of the Johnnie is quartzite and conglomerate that contains quartz and quartzite pebbles as large as 1.5 inches in diameter and dolomite and mica-schist cobbles as large as 6 inches in diameter.

The strata underlying the Johnnie Formation in the Funeral Mountains have not been conclusively identified, although some geologists have considered them to belong questionably to the Kingston Peak Formation of the Pahrump Group (Hunt and Mabey, 1966, p. A15). The questionable Kingston Peak of Hunt and Mabey, however, also includes strata that are considered here to be the Johnnie Formation and the lower part of the Stirling Quartzite. The strata underlying the Johnnie are composed of micaschist, quartzite, and marble and are much finer textured and contain more carbonate units than the typical Kingston Peak, although they could be a finer grained and carbonate-rich equivalent of the Kingston Peak. Troxel and Wright (1968) have suggested that the strata below the Johnnie in the Funeral Mountains may contain strata correlative to all three formations (Crystal Spring Formation, Beck Spring Dolomite, and Kingston Peak Formation) of the Pahrump Group.

REGIONAL CHARACTERISTICS OF JOHNNIE FORMATION

The Johnnie Formation, except for the Rainstorm Member, is lithologically variable in the southern Great Basin. Units recognized in the southern Death Valley–Kingston Range area cannot be recognized with certainty in areas to the north, nor can firm correlations be made between the Spring Mountains and the Desert Range. This variability is in contrast to the regional uniformity of higher units in the upper Precambrian and Lower Cambrian sequence in the southern Great Basin.

The Rainstorm Member of the Johnnie Formation, however, is regionally persistent and maintains consistent lithologic characteristics. The three subunits in the member (the siltstone unit, the carbonate unit, and the siltstone and quartzite unit) have similar lithologic characteristics from the southern Death Valley–Kingstone Range area on the south to the Nevada Test Site on the north, a distance of about a hundred miles. The Johnnie oolite, a layer of oolitic dolomite that is generally 6–12 feet thick and that is found in the siltstone unit within and near the base of the Rainstorm Member, is recognized from Old Dad Mountain (loc. 39) on the south to the Nevada Test Site on the north (loc. 56), a distance of 140 miles. Throughout this distance the Johnnie oolite is so distinctive that even a hand specimen can be consistently distinguished from other oolite layers in the upper Precambrian and Lower Cambrian sequence.

An eastward or southeastward change in facies occures in the Johnnie Formation in the area from the Funeral Mountains and Panamint Range to the Spring Mountains. In the Funeral Mountains, the entire Johnnie Formation consists of greenish-gray metasiltstone and granule conglomerate. Such granule conglomerate (fig. 3) has also been recognized in the Rainstorm Member in the northern part of the Resting Spring Range (loc. 21), in what is probably the Rainstorm Member at Trail Canyon (loc. 14) in the Panamint Range, and in what is classified in this report as the Rainstorm Member at a locality 6 miles north of Johnnie Wash in the Spring Mountains area. The conglomeratic strata north of Johnnie Wash were noted as unusual by Burchfiel (1964, p. 43), although at that time he favored the view that they were a part of the Stirling Quartzite rather than a part of the Johnnie. The occurrence of these conglomeratic strata in western areas and their absence in eastern areas suggests a western source that was perhaps not too far from the Funeral Mountains, where an angular unconformity separates the Johnnie Formation from the underlying strata.

STIRLING QUARTZITE

The Stirling Quartzite (named by Nolan, 1929, p. 463) is recognized in an area of about 15,000 square miles in the central region of the southern Great Basin (pl. 3*A*; fig. 9). It is a cliff-forming unit composed of light-colored quartzite, in part conglomeratic, and in most areas contains only minor amounts of siltstone and carbonate. The Stirling is contrasted with the underlying nonresistant and lithologically heterogeneous Johnnie Formation and with the overlying, darker colored, siltier Wood Canyon Formation, although the middle member of the Wood Canyon is predominantly quartzite

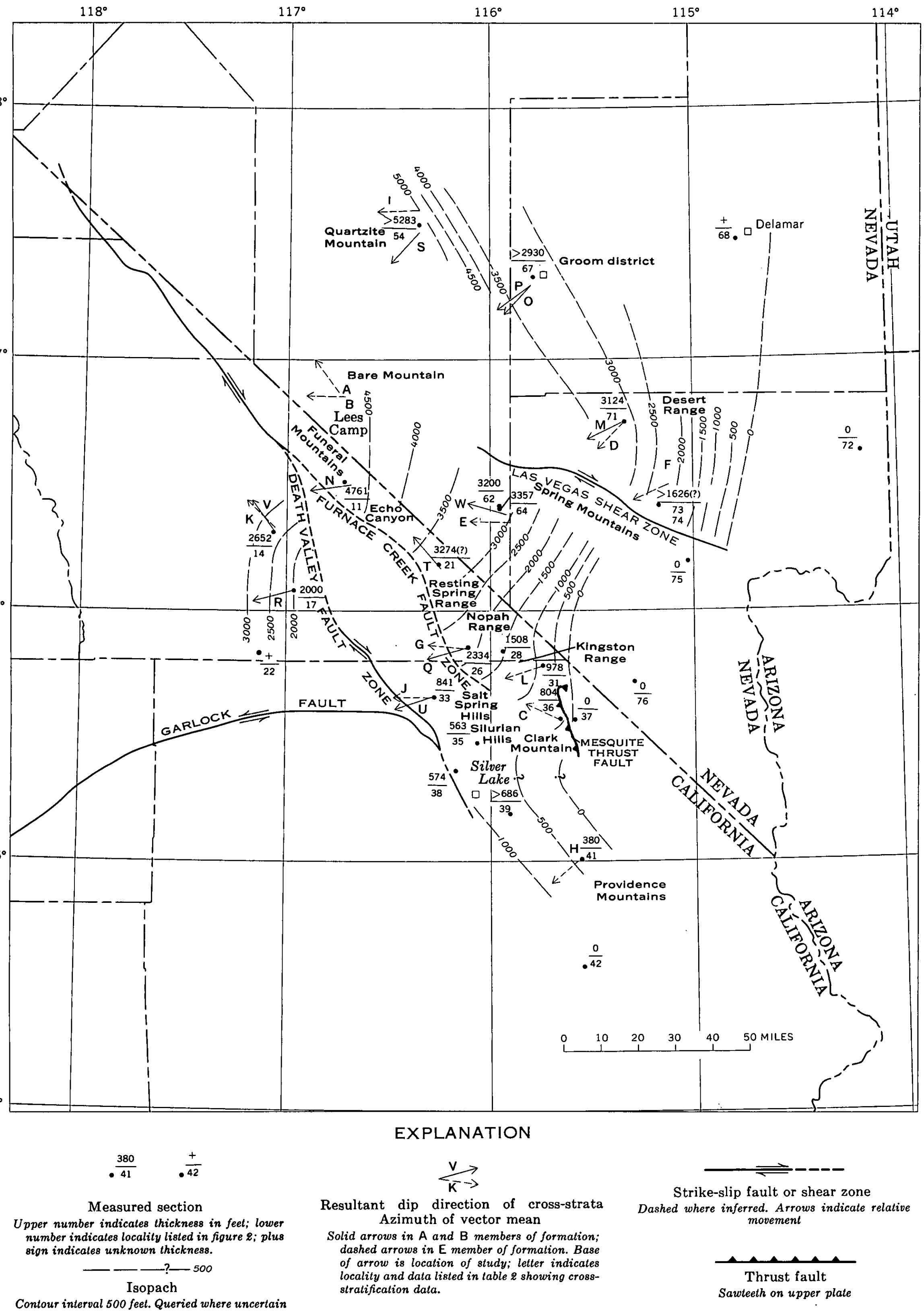


FIGURE 9.—Isopach map of the Stirling Quartzite and correlative strata showing resultant dip directions of cross-strata. Strata at locality 68 is part of Prospect Mountain Quartzite.

and can be confused with the Stirling. The Stirling thickens from 0 feet in the eastern part of the central region of the southern Great Basin to over 5,000 feet in the western part of the region; the change in thickness is accompanied by a change to generally more silty strata to the west (fig. 9). The lower part of the Stirling may be correlated to the west with part or all of the Wyman Formation, which is composed predominantly of phyllitic siltstone, silty claystone, and minor amounts of carbonate. The upper part of the Stirling changes facies westward and grades into dolomite that is called the Reed Dolomite in the western region.

The Stirling Quartzite has been considered to be Cambrian by some geologists (Nolan, 1929, p. 463; Hazzard, 1937a, p. 278–279) and Precambrian by other geologists (Barnes and others, 1965; Hunt and Mabey, 1966, table 1; and Stewart, 1966). In places it lies more than 2,000 feet below the lowest strata containing olenellid trilobites or archeocyathids, although trace fossils such as tracks and trials that are indicative of metazoan life occur in the basal member of the overlying Wood Canyon Formation. The correlation of the upper part of the Stirling with the Reed Dolomite in the White Mountains of the western region probably indicates that the span of metazoan life extends downward at least as far as the upper Stirling, because the Reed contains mollusklike fossils (Taylor, 1966; Cloud and Nelson, 1966). On the basis of these mollusklike fossils, Cloud and Nelson (1966) considered the Reed to be possibly Cambrian in age, although such an age for the Reed is not accepted here. The Stirling is considered here to be Precambrian on the basis of its position below the lowest occurrence of an olenellid-archeocyathid fauna in the stratigraphic sequence.

Included in the Stirling of this report are part of the unit that Hewett (1956, p. 26–31) called Prospect Mountain Quartzite in the Kingston Range and Clark Mountain area and part of the unit called Tapeats Sandstone (Hewett, 1956) or Prospect Mountain Quartzite (Hazzard, 1954, p. 30) in the Providence Mountains. The reasons for these reassignments have been discussed previously. (See description under "Eastern region" and "Johnnie Formation.")

At Delamar (loc. 68) in the northeastern part of the region, strata that are equivalent to the Stirling Quartzite are recognized by the writer, although these strata form a part of the unit called Prospect Mountain Quartzite by other geologists (Callaghan, 1937).

Throughout its area of recognition, the Stirling Quartzite overlies the Johnnie Formation and underlies the Wood Canyon Formation. Both the upper and lower contacts of the Stirling are conformable, except possibly for the lower contact in the Salt Spring Hills (loc. 33), the Silurian Hills (loc. 35), and the Silver Lake (loc. 38) areas and areas farther south (pl. 2). In these areas an unconformity is suggested by the absence of the uppermost unit of the Johnnie Formation (the siltstone and quartzite unit of the Rainstorm Member). This unit is about 200 feet thick in the Nopah Range (loc. 26) about 18 miles northeast of the part of the Salt Spring Hills where it is absent; thus its disappearance seems to be unusually abrupt. In the Silurian Hills, the carbonate unit of the Rainstorm Member is missing in addition to the siltstone and quartzite unit. Here the Stirling is only 28 feet above the Johnnie oolite; in the Salt Spring Hills, only 12 miles to the northwest, the Stirling is 141 feet above the oolite. The apparent absence of strata at the top of the Rainstorm Member in the Silurian Hills can perhaps best be explained by postulating their removal by pre-Stirling erosion, although no erosional surface has been noted at the contact. Hazzard (1937a, p. 305) has previously suggested the possibility of an unconformity at the base of the Stirling in the Nopah Range.

The Stirling Quartzite consists of dense cliff-forming quartzite and minor amounts of slope-forming siltstone and carbonate (fig. 10). It thickens from less than 1,000 feet in the southeastern part of the region to more than 5,000 feet in the northwestern part (fig. 9). Five members of regional extent are recognized in the Stirling, and these have been referred to informally from the bottom to top as the A, B, C, D, and E members (Stewart, 1966, p. C70).

A MEMBER

The A member is recognized throughout the extent of the Stirling Quartzite, except in some places in the southernmost part of the region where it cannot be differentiated from the B member. The A member consists predominantly of yellowish-gray or grayish-purple quartzite and conglomeratic quartzite and, in the upper half, some grayish-purple phyllitic siltstone. The top 100 feet or more is commonly somewhat coarser and more conglomeratic and forms a yellowish-gray top to the member.

The quartzite in the member is medium to coarse grained and is composed of rounded grains of quartz cemented into a tight mosaic by overgrowths of quartz (fig. 11). Some grains of muscovite-quartz schist and of muscovite-bearing quartzite occur, as well as some interstitial muscovite. Feldspar is common, but generally constitutes less than 1 percent of the rock (table 5), except in the topmost unit of the member, which contains as much as 15 percent K-feldspar in some samples. Two chemical analyses (table 6) show that the quartzite in the A member is high in SiO_2 (greater than 90 percent), but it is not as high in SiO_2 as the quartzite in the E member of the Stirling or as the Zabriskie Quartzite. Most of the quartzite in the A member is quartz arenite (according to the classification of Gilbert, in Williams and others, 1954), although some feldspathic arenite occurs in the topmost unit.

Parts of the quartzite units are laminated to thin bedded, but other parts are composed of tabular planar sets of cross-strata that range from less than 1 foot to more than 4 feet in thickness. Studies at ten localities (table 2; fig. 9) indicate

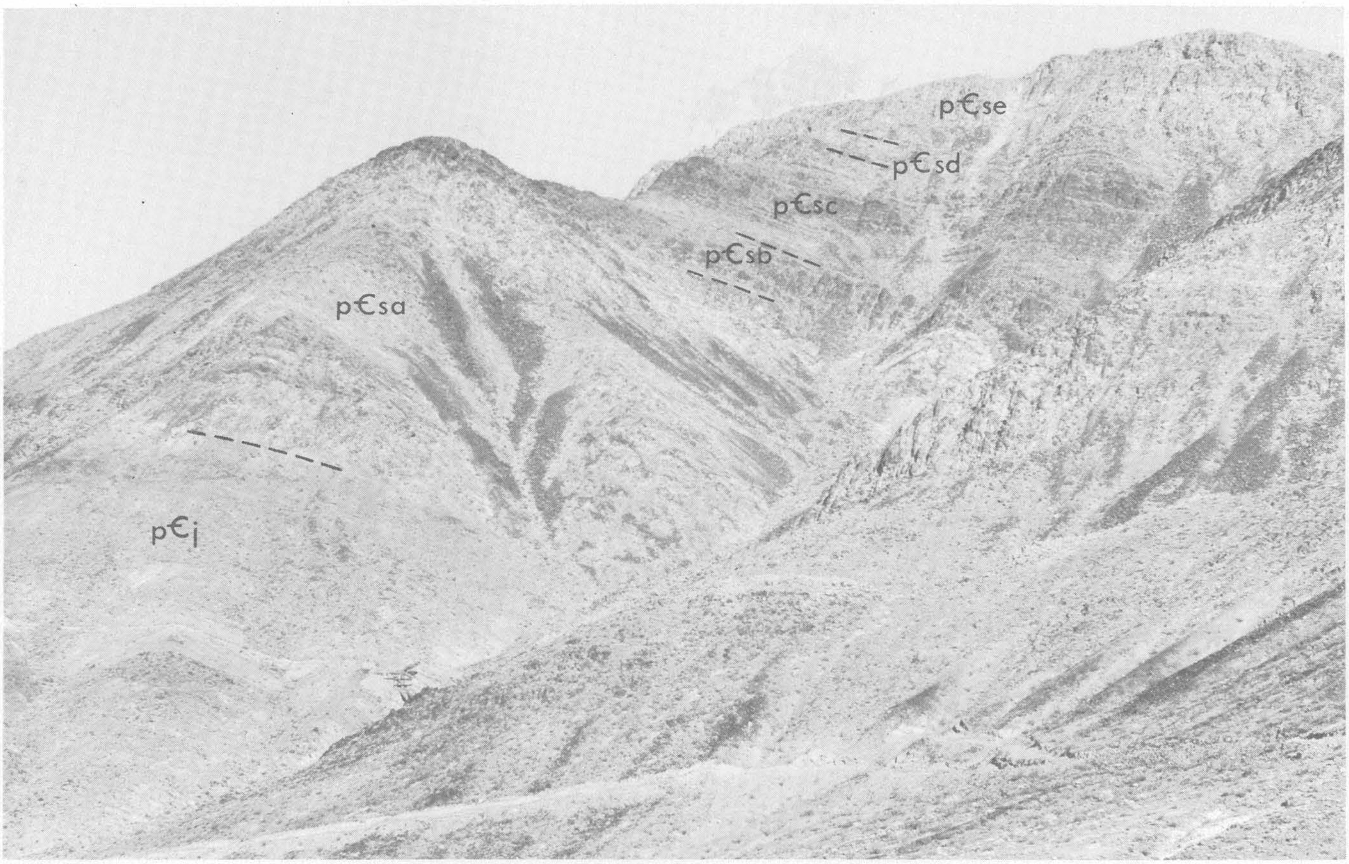


FIGURE 10.—Outcrop of the Johnnie Formation (p€j) and the Stirling Quartzite in southern part of the Nopah Range (loc. 26), Calif. The Stirling is divisible into five members: A member (p€sa), B member (p€sb), C member (p€sc), D member (p€sd), and E member (p€se).

TABLE 5.—*Mineral composition, in percent, of quartzite from the Stirling Quartzite as determined by approximately 100 point counts*

[Dashes (---) are entered if mineral was not detected in the 100 point counts]

Sample No.	Locality No. (fig. 2)	Quartz [1]	Muscovite-quartz schist and muscovite-bearing quartzite	K-feldspar	K-feldspar largely altered to sericite	Plagioclase	Argillite fragments	Opaques	Muscovite	Biotite	Carbonate minerals	Hematite or limonite	Other or unknown
Medium- to coarse-grained facies of E member													
JS-63-5	12	98	---	2	---	---	---	---	---	---	---	---	---
83	65	95	---	2	---	---	---	---	3	---	---	---	---
98	21	94	---	1	---	1?	---	---	4	---	---	---	---
99	21	90	---	9	---	2	---	---	---	---	---	---	---
113	14	97	---	---	---	---	---	---	3	---	---	---	---
64-114	14	95	---	3	---	---	---	---	2	---	---	---	---
125	26	97	---	---	---	---	---	---	3	---	---	---	---
Fine-grained facies of E member													
JS-63-4	12	74	---	15	---	10	---	---	---	---	---	---	---
64-30	54	53	---	---	---	1	---	---	18	---	28	---	---
131	57	55	---	---	---	6	---	---	16	2	21	---	---
138	57	50	---	18	---	3	---	---	2	---	27	---	---
142	57	76	---	8	---	7	---	---	2	---	8	---	---

TABLE 5.—*Mineral composition, in percent, of quartzite from the Stirling Quartzite as determined by approximately 100 point counts*—Continued

Sample No.	Locality No. (fig. 2)	Quartz [1]	Muscovite-quartz schist and muscovite-bearing quartzite	K-feldspar	K-feldspar largely altered to sericite	Plagioclase	Argillite fragments	Opaques	Muscovite	Biotite	Carbonate minerals	Hematite or limonite	Other or unknown
D member													
JS-63-112	14	73							1?		26		
124	26	92		3					4				
C member													
JS-63-123	26	55		7	2	5?			22			9	
B member													
JS-63-2	12	73		1		1?	3		19			3	
80	64	73		15		9	1		2			1	
109	14	55		4		2?	1	1	38				
Topmost unit of A member													
JS-63-1	12	87		8					6				
81	65	84		12			1		3				
97	21	84	1	10		1			5				
108	14	80	11						10				
122	26	84		15					2				
A member excluding topmost unit													
JS-63-6	12	91	3						6				
8	12	85	9						6				
9	12	81	7						11				2
78	64	92		1			1		5				
79	64	89					1		9				1
95	21	96	2				1		1				
96	21	91	5						4				
106	14	91	2	2					3				
107	14	88							4			8	
121	26	87		7	1		1		5				

[1] Includes quartz overgrowths and minor amounts (<3 percent) of quartzite and chert.

that the direction of dip of the cross-strata is dominantly to the west.

Parts of the A member are conglomeratic and contain granules and small pebbles of quartz, lesser amounts of quartzite, and very small amounts of red chert (jasper). These clasts are rarely more than ½–¾ inch in diameter; the largest clast, 3¼ inches in maximum diameter, was found in the Nopah Range (loc. 26).

Siltstone or phyllite units, which generally constitute about 10 percent of the member, are interstratified with the quartzite and are most common in the upper part of the member. In Echo Canyon (loc. 11 in strat. sections), phyllite makes up a larger proportion (30 percent) of the member and occurs in three units that range in thickness from 175 to 250 feet. The topmost of the phyllite units in Echo Canyon contains a 45-foot-thick limestone and dolomite unit about 50 feet below the top. This is the only carbonate unit known in the A member.

The A member ranges in thickness from 130 feet to over 1,800 feet (table 7). The direction of thickening is to the northwest, the same as that for the formation as a whole.

B MEMBER

The B member is one of the most difficult members to recognize, and in the southern part of the region (loc. 36, 38, 41) it apparently cannot be distinguished from the underlying A member. Commonly the B member appears to be transitional between the quartzite of the A member and the siltstone of the overlying C member, but nonetheless the unit appears to be distinctive enough to warrant member status.

TABLE 6.—*Chemical and modal characteristics of upper*

[Rapid rock analyses: P. L. D. Elmore, Gillison Chloe, S. D. Botts, Lowell Artis, Hezekiah Smith, Dennis Taylor, and J. L. Glenn. Methods similar to those described in used: 0=looked for but not detected; results are reported in percent to the nearest number in series 1, 0.7, 0.5, 0.3, 0.2, 0.15, and 0.1, . . . ; which represent approximate for but not detected: Ag, As, Au, Bi, Cd, Ge, Hf, Hg, In, Li, Mo, Pd, Pt, Re, Sb, Sn, Ta, Te, Th, Tl, U, W, and Zn; Pr, Nd, Sm, and Eu looked for but not detected in not detected]

Region	Western			Central	
Formation	Campito Formation			Zabriskie Quartzite	
Member	Andrews Mountain Member				
Laboratory No.	M100848W	M100849W	M100850W	M100837W	M100838W
Field No.	823-37J	823-40J	823-53J	JS-61-16	JS-61-45
Locality No. (fig. 2) or location	5	5	(1)	20	(2)
					Rapid rock
SiO_2	62.9	76.2	57.3	97.8	97.5
Al_2O_3	14.4	11.5	14.8	.55	.45
Fe_2O_3	4.1	2.1	5.1	.10	.35
FeO	4.3	.28	6.6	.20	.08
MgO	2.9	.16	2.4	.00	.00
CaO	.41	.82	1.5	.00	.02
Na_2O	3.5	3.3	2.2	.12	.10
K_2O	3.2	3.9	2.8	.00	.12
H_2O^-	.14	.08	.13	.00	.00
H_2O^+	1.7	.39	3.4	.40	.43
TiO_2	2.0	.70	2.2	.00	.00
P_2O_5	.31	.36	.31	.03	.03
MnO	.15	.03	.12	.00	.00
CO_2	<.05	<.05	.14	<.05	<.05
Sum	100	100	99	99	99
					Semiquantitative
B	0.001	0.0015	0.002	0.001	0.001
Ba	.07	.1	.03	.005	.003
Be	.0002	.0002	.0002	0	0
Ce	0	.01	0	0	0
Co	.003	.0002	.005	0	0
Cr	.005	.003	.007	.0003	.0005
Cu	.01	.0003	.01	.0002	.0002
Ga	.0015	.001	.003	0	0
La	.002	.003	.005	0	0
Nb	.002	.002	.003	.00070	0
Ni	.007	.0007	.007	0	.00015
Pb	.001	.002	0	0	0
Sc	.0015	.001	.002	0	0
Sr	.007	.005	.007	0	0
V	.015	.005	.02	0	0
Y	.003	.005	.005	0	0
Yb	.0003	.0005	.0005	0	0
Zr	.02	.02	.03	.007	.01
					Mineral
Quartz [3]	41	52	20	n.d.	n.d.
K-feldspar	-----	1.9	-----	n.d.	n.d.
K-feldspar largely altered to sericite	-----	-----	-----	n.d.	n.d.
Plagioclase	4	12	1	n.d.	n.d.
Argillite fragments	-----	-----	-----	n.d.	n.d.
Opaques	5	3	8	n.d.	n.d.
Muscovite	28	9	46	n.d.	n.d.
Biotite	12	-----	1	n.d.	n.d.
Chlorite	10	-----	24	n.d.	n.d.
Carbonate minerals	-----	6	-----	n.d.	n.d.
Hematite or limonite	-----	-----	-----	n.d.	n.d.
Others and unknowns	-----	-----	-----	n.d.	n.d.

[1] Lat 37°19′, long 117°43′.
[2] Sec. 20 (unsurveyed), T. 13 S., R., 48 E.
[3] Includes quartz overgrowths and minor amounts (<3 percent) of quartzite and chert.

The B member consists predominantly of grayish-red, grayish-purple, and medium-light-gray very fine to fine-grained silty quartzite and coarse sandy siltstone. The strata are laminated to very thin bedded; the laminae and beds are slightly irregular or wavy, in places suggesting crude ripple laminae. In places, the very fine to fine-grained quartzite contains flakes of siltstone that are ¼–1 inch in diameter. The upper third of the member contains yellowish-gray to very pale orange fine- to coarse-grained quartzite in 1–12-inch layers interstratified with the finer grained quartzite and siltstone. The fine- to coarse-grained quartzite increases in amount upward and forms a ledge near the top of the member. It is laminated to very thin bedded, although small-scale cross-strata occur in places, and parallel ripple marks are locally abundant (fig. 12).

In the Funeral Mountains (locs. 11, 58), a few layers of dolomite, silty dolomite, and sandy dolomite occur from 100 to 200 feet above the base of the B member. The dolomite is pinkish gray, pale red, and grayish orange pink and occurs in beds that are 1–10 inches thick.

The B member is less than a few hundred feet thick in much of its area of distribution (table 7). It is thicker in

Precambrian and Lower Cambrian quartzite and sandstone

U.S. Geol. Survey Bull. 1144-A modified to use the atomic absorption technique. Semiquantitative spectrographic analysis: six-step analysis by Chris Heropoulos; symbol midpoints of interval data on a geometric scale. The assigned interval for semiquantitative results will include the quantitative value about 30 percent of the time. Looked samples containing La and Ce. Mineral composition: based on approximately 100 point counts in thin section; symbols used: n.d.=not determined; dashes (———) =

Central—Continued

Zabriskie Quartzite—Continued		Wood Canyon Formation, Middle member			Stirling Quartzite, E member		Stirling Quartzite, A member	
M100839W JS-63-22 7	M100840W JS-63-118 14	M100841W JS-63-85 66	M100842W JS-63-100 21	M100843W JS-63-116 14	M100844W JS-63-113 14	M100845W JS-63-114 14	M100846W JS-63-78 64	M100847W JS-63-107 14
analysis								
96.6	97.4	81.6	87.4	94.8	96.5	96.4	94.7	90.5
.93	.73	8.6	5.2	2.0	1.3	1.7	2.4	3.4
.70	.18	2.4	1.8	1.1	.41	.13	.61	.32
.08	.20	.28	.20	.08	.08	.08	.16	.28
.00	.00	.70	.43	.06	.06	.00	.08	.05
.03	.00	.10	.11	.09	.00	.03	.03	.03
.00	.00	.74	.20	.19	.06	.00	.00	.00
.00	.00	3.8	2.3	.40	.28	.38	.67	.70
.00	.00	.10	.15	.12	.05	.06	.06	.04
.43	.61	1.2	1.4	.85	.43	.33	.28	.56
.25	.02	.38	.31	.20	.00	.00	.06	.32
.04	.04	.08	.08	.09	.05	.05	.05	.15
.00	.00	.02	.00	.00	.00	.00	.00	.00
<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
99	99	100	100	100	99	99	99	99
spectrographic analysis								
0.002	0.001	0.002	0.003	0.0015	0.001	0.0015	0.002	0.001
.003	.005	.05	.03	.01	.007	.015	.015	.015
0	0	.0001	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	.0005	.0005	.0002	0	0	0	.0003
.0005	.0003	.001	.01	.0005	.0003	.0002	.0005	.001
.0005	.0002	.0007	.001	.0015	.0003	.0005	.0002	.0007
0	0	.001	.0007	.0002	0	0	.0002	.0003
0	0	.003	0	0	0	0	0	.003
.001	0	.001	.001	.001	0	0	.001	.001
0	.0001	.001	.0007	.0003	.0002	.0002	.00015	.0015
0	0	.0015	0	0	0	0	0	0
0	0	.0005	.0003	0	0	0	0	0
.001	0	.003	.002	0	0	0	0	.003
0	0	.007	.005	.0015	.0007	.0007	.0007	.005
0	0	.002	.0015	.001	0	0	0	.0015
.00015	.00007	.0002	.00015	.0001	0	0	0	.00015
.05	.015	.03	.02	.02	.01	.003	.01	.03
composition								
98	99	64	79	94	97	95	92	88
---	---	18	8	3	---	3	1	---
---	---	---	7	---	---	---	---	---
---	---	3	---	---	---	---	---	---
---	---	4	1	---	---	---	1	---
---	---	---	---	---	---	---	---	---
2	1	12	6	2	3	2	5	4
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	8
---	---	---	---	1	---	---	---	---

the Funeral Mountains (more than 600 ft) and the northern part of the southern Great Basin (500–1,100 ft at locs. 54, 67, 71).

C MEMBER

The C member has been recognized throughout the extent of the Stirling Quartzite and forms a nonresistant middle part of the formation.

In most areas the C member is composed predominantly of siltstone in the lower part and quartzite in the upper part. The siltstone is greenish gray, light olive gray, or grayish red and is micaceous, laminated, and commonly platy. In places it is sandy and grades into silty sandstone. In some areas almost all the siltstone in the member is greenish gray, but in other areas it is almost entirely grayish red. The reason for this color difference is not adequately understood, although metamorphism may have altered the original red rock to green. The possibility of such alteration is supported by the observation that the green siltstone occurs in areas where signs of metamorphism, such as a weak schistosity, are more apparent than they are in areas where the siltstone is red.

The quartzite in the C member is pale red, grayish red, or yellowish gray and includes two types: (1) silty very fine to

TABLE 7.—*Thickness, in feet, of Stirling Quartzite and its members*

[Symbols used: ne=not exposed; nm=not measured; 0=absent]

Locality	Locality No. (fig. 2)	Stirling Quartzite (*incomplete)	A member (*incomplete)	B member	C member (*incomplete)	D member (*incomplete)	E member (*incomplete)
Providence Mountains	41	380	160		144	0	76
Northwest of Kelso	40	nm	nm	nm	nm	0	239
Silurian Hills	35	563	130	52	231	5	145
Silver Lake	38	574	108		206	0	260
Old Dad Mountain	39	*686	155	38	210	133	*150±
Northwest of Clark Mountain	36	804	178		431	55	140
Salt Spring Hills	33	841	150	85	246	90	270
Winters Pass Hills	31	978	160	88	309	61	360
Western part of Kingston Range	28	1, 508	335	123	352	20	678
Las Vegas Range	74, 73	*1, 626(?)	500(?)	285	626	0	215
Nopah Range	26	2, 334	822	220	328	155	809
Black Mountain	23	*814±	663±	100(?)	nm	nm	nm
Trail Canyon	14	2, 652	1, 076±	200	328	406	642±
Desert Range	71	3, 124	1, 010±	643	605±	0	866
Northern part of Resting Spring Range	21	3, 274(?)	1, 279(?)	208	462	421	904
Wood Canyon	64	3, 357	1, 253	322	608	39	1, 135
Groom district	67	*2, 930	*555	755	555	0	1, 065
Echo Canyon No. 2	11	4, 761	1, 866	640	536	451	1, 268
Lees Camp	58	*2, 511	*365	623±	1, 523±	nm	nm
Bare Mountain	57	*1, 929	ne	ne	*57	466	1, 406
Quartzite Mountain	54	*5, 283	*1, 840	1, 132	835	283	1, 193

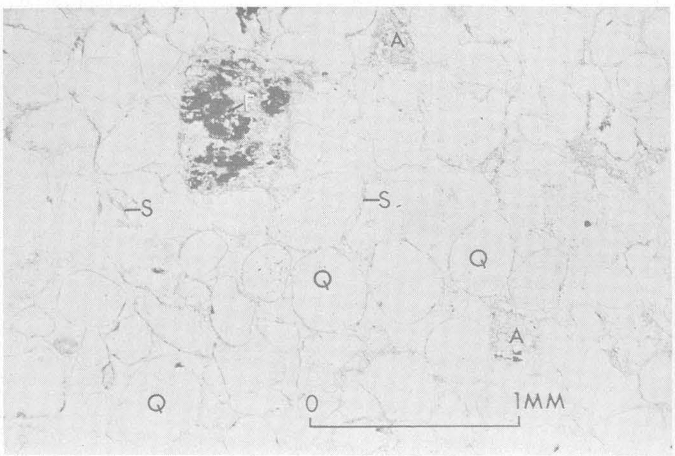


FIGURE 11.— Photomicrograph of quartz arenite in the A member of the Stirling Quartzite. Rounded grains of quartz (Q), and scarce K-feldspar (F), argillite fragments (A), and interstitial sericite (S) cemented into tight mosaic by secondary overgrowths of quartz. K-feldspar is stained, using sodium cobaltinitrite. Sample JS–63–78, loc. 64. Plane light.

fine-grained quartzite, dominant in the lower part of the member, and (2) relatively clean fine- to medium-grained quartzite, dominant in the upper part of the member. Both types are laminated to very thin bedded; a few low-angle small-scale cross-strata and some ripple-marked layers occur near the top of the member. Flakes of siltstone that are ¼–1 inch in diameter are common in the finer grained quartzite. The amount of quartzite increases gradually upward from a very minor amount in the lower part to a predominant amount in the upper part. Near the top, 90 percent of the member is commonly quartzite.

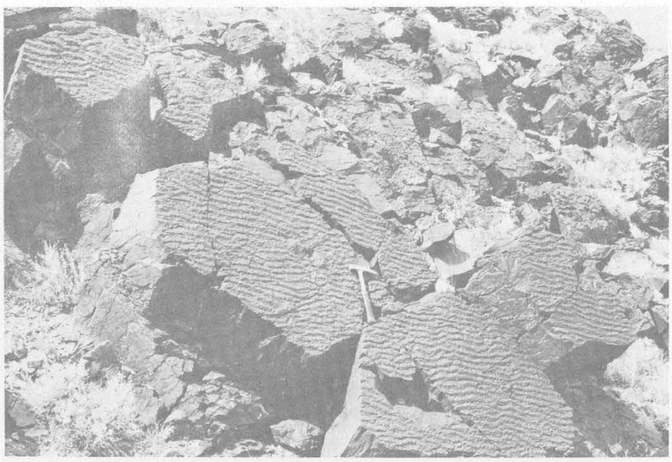


FIGURE 12.—Parallel ripple marks in upper part of the B member of the Stirling Quartzite, southern part of the Nopah Range (loc. 26), Calif.

A few layers of dolomite, a few inches to a foot thick, are characteristically found in the basal 60 feet or less of the member. These dolomite layers are a widespread stratigraphic marker and are useful in establishing regional correlations and locating the base of the C member. The dolomite is pale yellowish brown and moderate yellowish brown, very finely crystalline, and evenly laminated. In part of the Funeral Mountains the thickness of the interval containing dolomite is much greater, and the dolomite-bearing interval forms a conspicuous stratigraphic unit. Near Lees Camp in the Funeral Mountains, for example, the lower 500 feet of the C member contains dolomite layers, which constitute nearly 10 percent of this 500-foot interval.

At several localities (locs. 31, 33, 36, 41) in the southern part of the southern Great Basin region, abundant layers or a unit of yellowish-gray laminated fine-grained quartzite occur near the top of the basal third of the C member. The quartzite sequence is overlain and underlain by units composed predominantly of siltstone. The underlying unit (loc. 33) locally contains limestone and dolomitic limestone that are apparently correlative with the persistent interval of dolomite at the base of the C member. The position of the carbonate layers seems to support the placing of the quartzite sequence in the C member, although the presence of quartzite is unusual in this part of the C member.

The C member changes facies gradually to the northwest across the central region of the southern Great Basin. In the eastern part of the region siltstone commonly constitutes only a third or half of the member, but to the northwest the relative amount of siltstone increases, and in the Funeral Mountains siltstone constitutes about three-fourths of the member. The facies change is accompanied by an increase in the amount of dolomite in the lower part of the member.

The C member increases in thickness (table 7) to the northwest in the southern Great Basin, following the same general thickness trends as the formation as a whole. It is at most only a few hundred feet thick in the eastern and southeastern parts of the central region and thickens to perhaps 1,500 feet in parts of the Funeral Mountains (loc. 58).

D MEMBER

The D member is a very conspicuous unit in most of the western exposures of the Stirling, but is inconspicuous in the eastern exposures. Where well defined, as in the Funeral Mountains (locs. 11, 58), on Bare Mountain (loc. 57), and on Quartzite Mountain (loc. 54), it is composed of light-gray to very pale orange very finely crystalline laminated dolomite and limestone in the lower half and greenish-gray siltstone, very pale orange fine- to medium-grained quartzite, and pale-yellowish-brown limestone, dolomite, and sandy dolomite in the upper half. In these areas, the D member is about 300–400 feet thick and forms a light-colored ledge. Lithologically the D member in these areas resembles the Noonday Dolomite, with which it has been confused by some geologists.

In most of the eastern exposures, the member is less than 100 feet thick and consists of dark-yellowish-brown-weathering fine- to medium-grained dolomitic sandstone and sandy dolomite, very pale orange finely crystalline dolomite, yellowish-gray fine- to medium-grained quartzite, and rare greenish-gray siltstone. In many places in the eastern exposures, most of the member is quartzite; because the dolomitic strata are scarce, the member is difficult to separate in these eastern exposures from the overlying E member. Nonetheless, the dolomitic strata of the D member are widespread in the region, and even though the member is vaguely defined, it is useful in regional correlation.

The D member has not been recognized in the northeastern part of the region (locs. 67, 71, 73, 74). Silty limestone, limy sandstone, and dolomite occur in the upper part of the Stirling in the localities mentioned, and as described by Stewart and Barnes (1966) and as shown on plate 2, they are included in the E member rather than the D member.

E MEMBER

The E member is recognized throughout the area of distribution of the Stirling Quartzite. In most areas it forms a light-colored cliff at the top of the Stirling.

The E member is composed predominantly of pinkish-gray and minor yellowish-gray medium- to coarse-grained quartzite. The quartzite is composed of rounded grains of quartz cemented into a tight mosaic by overgrowths of quartz (fig. 13). The quartz content is in excess of 90 percent as determined by point count analysis of thin sections (table 5), and this determination is confirmed by chemical analyses indicating over 96 percent SiO_2 in two samples. The rock is classified as a quartz arenite, because K-feldspar and interstitial muscovite amount to only a few percent in most samples. The quartzite is laminated to very thin bedded and contains many tabular planar and a very few trough sets of small- to medium-scale cross-strata. Studies at 12 localities show that the cross-strata dip predominantly to the west (fig. 9; table 2).

Conglomerate or conglomeratic quartzite layers constitute about 5 percent of the member and are most common in the top 100 feet. The conglomerate consists of granules and pebbles of quartz, minor amounts of red chert (jasper), and very small amounts of quartzite. The red chert granules and pebbles in this member stand out conspicuously because their

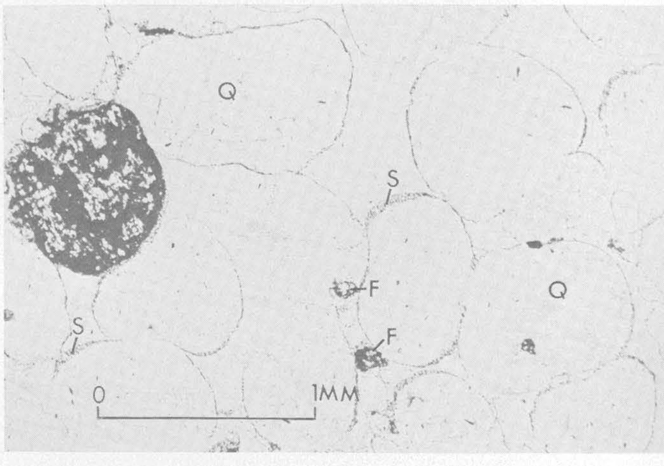


FIGURE 13.—Photomicrograph of quartz arenite in the E member of the Stirling Quartzite. Rounded grains of quartz (Q) and K-feldspar (F), and scarce sericite (S) cemented into a tight mosaic by secondary overgrowths of quartz. K-feldspar occurs as either medium to coarse grains or as very fine grains. K-feldspar is stained, using sodium cobaltinitrite. Sample JS–63–83, loc. 65. Plane light.

color contrasts with the pinkish-gray quartzite. Most of the pebbles are no more than ½–¾ inch in diameter, although the largest are 1–2 inches in diameter.

The lower part of the E member changes facies from mostly massive medium- to coarse-grained quartzite in the eastern part of the region to interstratified siltstone, fine-grained quartzite, and carbonate rocks in the western part. The western facies is best developed at Bare Mountain (loc. 57) and at Quartzite Mountain (loc. 54). At Bare Mountain the lower 1,100 feet and at Quartzite Mountain the lower 800 feet of the E member are composed of siltstone, fine-grained quartzite, and carbonate, and the upper 300–400 feet is pinkish-gray fine- to medium-grained quartzite similar to that which constitutes the entire member in the eastern part of the region. A minor amount of siltstone and fine-grained quartzite similar to that at Bare Mountain and Quartzite Mountain also occurs in the lower part of the E member in Echo Canyon (loc. 11). Siltstone, silty limestone, limy siltstone, and dolomite occur in the E member at Groom (loc. 67) and in the Desert Range (loc. 71); these strata may be an eastward-extending tongue of the silty and carbonate-bearing lower part of the E member.

The lower finer grained part of the E member at Bare Mountain and Quartzite Mountain is composed of greenish-gray and olive-gray siltstone, yellowish-gray and pale-yellowish-brown very fine to fine-grained (rarely medium-grained) laminated quartzite, and a few layers of limestone or dolomite. The quartzite is commonly dolomitic or limy and weathers dark yellowish brown. The fine-grained quartzite in the lower part of the E member generally contains more carbonate minerals, more muscovite, and more feldspar than the medium- to coarse-grained strata of the E member (fig. 14), and one sample contains 21 percent feldspar (29 percent of the noncarbonate minerals in the rock). These fine-grained quartzite beds include calcareous quartz arenite, calcareous feldspathic arenite, feldspathic wacke, and calcareous feldspathic wacke.

Approximately the top 100–150 feet of the E member in the Nopah Range (loc. 26), the Spring Mountains (loc. 64), and the northern part of the Resting Spring Range (loc. 21) is transitional into the Wood Canyon Formation. This part of the member consists of yellowish-gray, greenish-gray, and dark-yellowish-brown fine- to medium-grained quartzite and minor amounts of greenish-gray and pale-yellowish-brown siltstone; in some places it contains light-brown-weathering sandy dolomite and dolomitic sandstone. These strata form a less resistant, and in many places darker colored, top of the Stirling. Such strata were placed in the top part of the Stirling by Nolan (1924, p. 32–33) in the type area of the formation in the Spring Mountains. Hazzard (1937a, fig. 3d), however, assigned such transitional strata in the Nopah Range (loc. 26) to the Wood Canyon Formation. The writer has followed the practice of Nolan in assigning these strata in the Nopah Range, the Spring Mountains, and the northern Resting Spring Range to the Stirling, because they consist predominantly of quartzite similar to that in the underlying part of the E member and also because such usage is in accord with the original definition of the Stirling. To the north, however, the transitional strata contain more siltstone and are inseparable from the Wood Canyon Formation. This change takes place between the Resting Spring Range and Echo Canyon (pl. 2) and between the Spring Mountains and the Desert Range (pl. 2). In these northern areas, the top contact of the Stirling is placed lower to include these transitional strata in the Wood Canyon.

The E member ranges in thickness from less than 100 feet to more than 1,400 feet and is thickest in the western and northwestern parts of the central region (table 7).

WOOD CANYON FORMATION

The Wood Canyon Formation (named by Nolan, 1929, p. 463–464) is recognized in an area of about 15,000 square miles in the southern Great Basin (pl. 3*B*; fig. 15). It consists in the lower and upper parts of slope-forming siltstone, fine-grained quartzite, and minor amounts of dolomite and in the middle part of cliff-forming fine- to medium-grained quartzite and minor amounts of conglomerate and siltstone. The formation is darker colored and contains more siltstone than the underlying Stirling Quartzite, although parts of the two formations are similar and could be confused with each other, particularly in a structurally complex area. The overlying Zabriskie Quartzite is an almost entirely dense and clean quartzite that forms a light-colored ledge above the darker, more silty, and in part slope-forming Wood Canyon.

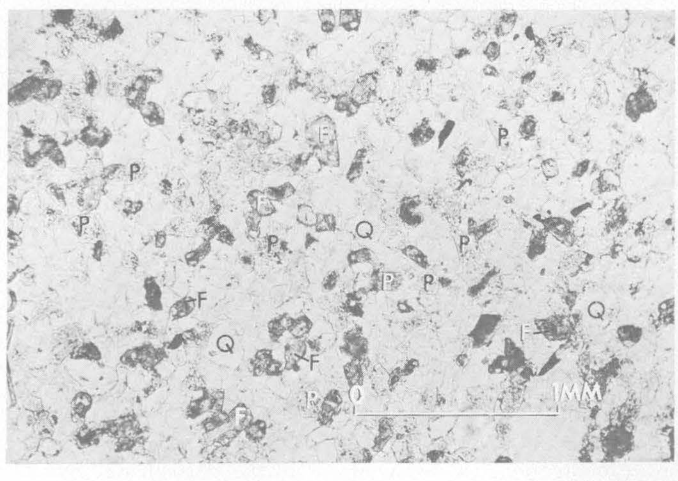


FIGURE 14.—Photomicrograph of arkosic arenite in fine-grained facies of the E member of the Stirling Quartzite. Composed of angular to subangular grains of quartz (Q), K-feldspar (F), and plagioclase (P) tightly cemented by quartz. Contains about 15 percent K-feldspar and 10 percent plagioclase. K-feldspar is stained, using sodium cobaltinitrite. Sample JS–63–4, loc. 12. Plane light.

The Wood Canyon forms a westward-thickening wedge of sedimentary rocks that is about 4,000 feet thick in western exposures. Correlative strata in the western region are over 6,000 feet thick and consist of a conformable sequence of strata composed, from bottom to top, of the Deep Spring Formation, the Campito Formation, the Poleta Formation, and the lowermost part of the Harkless Formation. These correlations to the west are discussed under the descriptions of the formations in the western region.

The Wood Canyon Formation has been considered to be Cambrian by Nolan (1929, p. 463–464) and Hazzard (1937a, p. 278), Cambrian and Cambrian(?) by Hunt and Mabey (1966, table 1), and Cambrian and Precambrian by Barnes, Christiansen, and Byers (1965) and Stewart (1966). The upper member of the Wood Canyon contains olenellid trilobites and archeocyathids and thus is Lower Cambrian. The middle and lower members contain trace fossils indicating metazoan life, but no recognizable trilobites or archeocyathids. A Precambrian and Cambrian age is used here for the Wood Canyon Formation, because it lies in part below and in part above the lowest occurrence of an olenellid trilobite–archeocyathid fauna in the stratigraphic sequence.

The Wood Canyon Formation, as recognized in this report, forms part of the unit that Hewett (1956, p. 29–31) called Prospect Mountain Quartzite in the Kingston Range and the Clark Mountain area and part of the unit called Tapeats Sandstone (Hewett, 1956) or Prospect Mountain Quartzite (Hazzard, 1954, p. 30) in the Providence Mountains. The reasons for these reassignments have been discussed previously. (See description under "Eastern region" and "Johnnie Formation.")

Strata that are lithologically correlative with the Wood Canyon Formation are also recognized beyond the area where the name is officially used. Strata correlated here with the Wood Canyon Formation constitute a part of the Tapeats Sandstone in the Marble Mountains (loc. 42) and the eastern part of the Clark Mountain area (loc. 37), and also a part of the Prospect Mountain Quartzite (Callaghan, 1937, p. 15–17; and Merriam, 1964, p. 9–13) at Delamar (loc. 68) and Pioche (loc. 69). The Wood Canyon Formation and correlative strata are shown on the isopach maps and stratigrahic diagrams (fig. 15, pl. 3*B*).

In the Daylight Pass and Bare Mountain areas, Cornwall and Kleinhampl (1964, p. J2–J4) proposed the names Daylight Formation and Corkscrew Quartzite for strata herein considered to be the Wood Canyon Formation and the Zabriskie Quartzite, respectively. As correltions into these areas now seem to be well established (pl. 2), the names Daylight and Corkscrew are no longer needed and are here abandoned (H. R. Cornwall and F. J. Kleinhampl, oral commun. 1966).

In most of its area of recognition, the Wood Canyon Formation conformably overlies the Stirling Quartzite, and a transitional sequence is found between the formations in some areas. In the southeastern part of its area of recognition (locs. 41, 32, and 73, pl. 2), however, an unconformity possibly exists between the formations. Here the conglomeratic and arkosic middle member of the Wood Canyon Formation rests on the Stirling; the lower member of the formation is missing, possibly as a result of erosional truncation. An erosion surface, however, was not detected at the base of the middle member, although even if such a surface were present, it would be difficult to demonstrate because of the small number of outcrops. In the southeastern part of the southern Great Basin region (locs. 42 and 37, pl. 2), strata which are laterally equivalent to the Wood Canyon Formation, but which are included in the Tapeats Sandstone, overlap the Stirling and rest unconformably on older Precambrian gneiss and schist.

The Wood Canyon Formation is everywhere overlain by the Zabriskie Quartzite. In almost all the central region, this contact is noticeably transitional, but in a few areas (locs. 66, 73) along the eastern part of the central region where the Zabriskie is thin, the contact is sharp and probably erosional.

The Wood Canyon Formation is divided into three members (Stewart, 1966, p. C71) of regional extent: a lower member composed of siltstone and fine-grained quartzite and of minor amounts of dolomite; a middle member composed of arkosic and, in part, conglomeratic sandstone and quartzite and of minor amounts of siltstone; and an upper member that is lithologically similar to the lower member (fig. 16).

LOWER MEMBER

The lower member extends throughout much of the area in which the Wood Canyon Formation is recognized. It is absent along the eastern and southeastern parts of the central region of the southern Great Basin.

The lower member consists predominantly of light-olive-gray, greenish-gray, and minor amounts of dusky-yellow laminated fine- to coarse-grained siltstone, some of which is platy and some of which breaks into angular fragments. Worm borings or castings, mostly parallel to stratification, indistinct drag marks, animal scratches, and possible tracks are fairly common in the lower member and are the lowest occurrence of such trace fossils in the Precambrian and Cambrian succession. The siltstone is composed of subangular silt-sized grains of quartz and minor amounts of feldspar set in a mesh of muscovite and chlorite (table 4).

Interstratified with the siltstone are very thin to thin layers of yellowish-gray laminated very fine to fine-grained quartzite that constitute about 10–20 percent of the member. The laminae in these layers are characteristically well defined and even and are similar to those in the quartzite in the

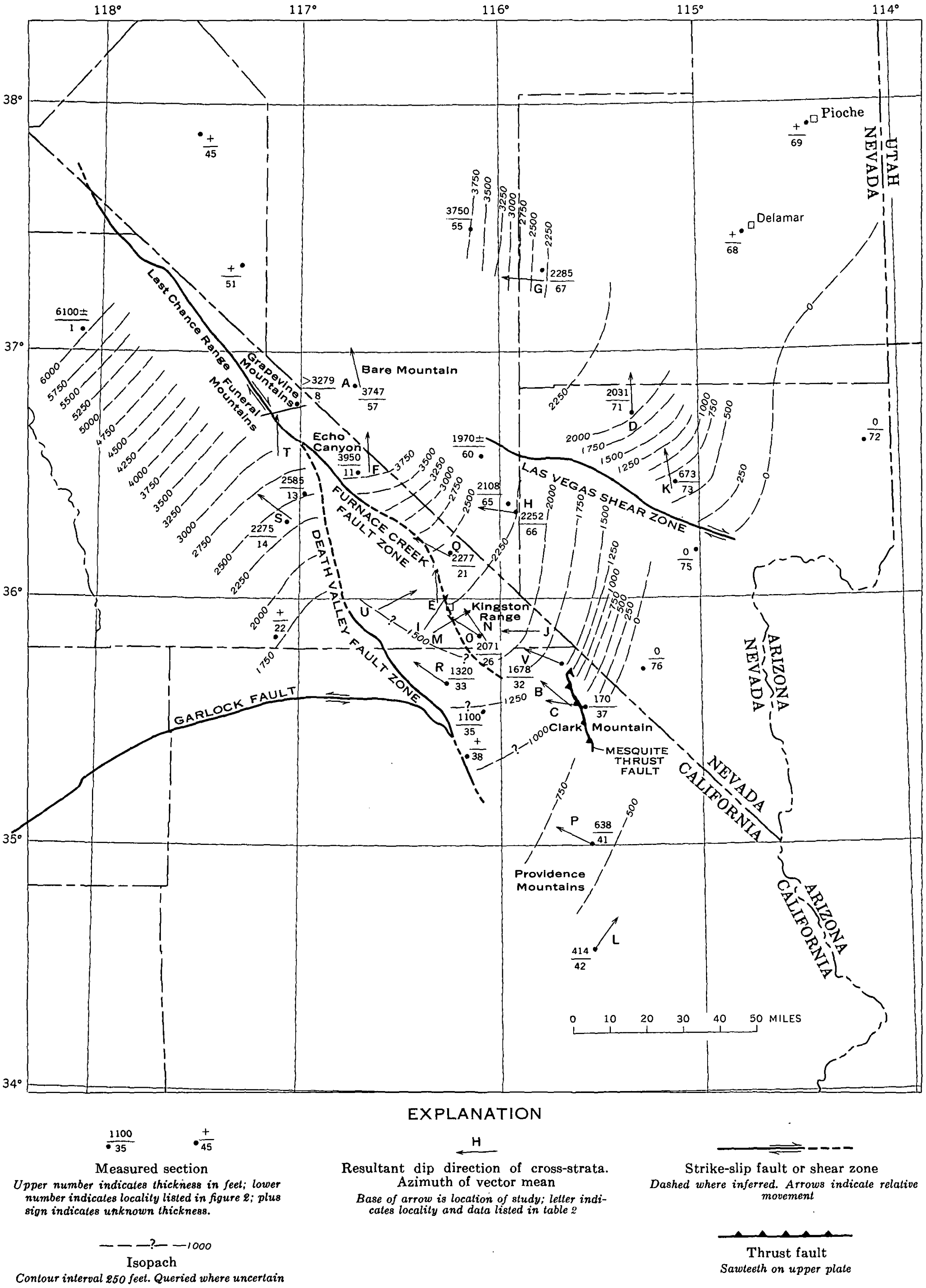


FIGURE 15.—(See left column of facing page for explanation.)

upper member (fig. 23). The quartzite (fig. 17) is a mosaic of quartz and contains a few percent to as much as 22 percent feldspar and minor amounts of interstitial muscovite (table 8).

The quartzite ranges in composition from calcareous quartz arenite to feldspathic arenite. Some samples contain a mixture of K-feldspar and plagioclase, whereas others contain only plagioclase that, as indicated by X-ray diffraction investigation, is albite. The deposition of a sediment containing only one type of feldspar (albite) is difficult to explain unless the sediment is derived from a local albite-rich terrane. Such an explanation is unlikely, however, because the clastic material in the Precambrian and Cambrian succession in the southern Great Basin appears to have been derived from a lithologically complex igneous and metamorphic terrane lying far to the east. (See sections on "Paleogeography" and "Provenance, maturity, and mineral sorting.") Thus, the assumption that an albite-rich terrane existed does not seem to explain the abundance of albite in these rocks, and the only other possible explanation seems to be that the albite formed either by a diagenetic process on the ocean floor or that it formed during still later metamorphism. The latter explanation is favored because many if not all of the rocks in the Precambrian and Cambrian succession show signs of dynamo-thermal metamorphism.

Dolomite layers that are medium gray on fresh surfaces, but weather moderate yellowish brown, occur in the lower member of the Wood Canyon Formation. The dolomite is very finely crystalline, commonly contains a minor amount of clastic silt-size quartz, and is evenly laminated to thin bedded, although locally it contains small-scale cross-strata. The dolomite occurs predominantly in three regionally persistent units in the lower member (pl. 2). Siltstone and fine-grained quartzite are interstratified with the dolomite in some of these units.

The lower member increases in thickness from a few hundred feet in the eastern part of the region to over 1,400 feet in the western part (table 9).

TABLE 8.—*Mineral composition, in percent, of quartzite and sandstone from the Wood Canyon Formation as determined by approximately 100 point counts*
[Dashes (--) are entered if mineral was not detected in the 100 point counts]

Sample No.	Locality No. (fig. 2)	Quartz [1]	K-feldspar	K-feldspar largely altered to sericite	Plagioclase	Argillite fragments	Opaques	Muscovite [2]	Chlorite	Carbonate minerals	Others or unknowns
Upper member											
JS-63-89	66	69	4	--	--	4	3	1	2	1	[3] 17
92B	66	79	11	--	7	2	1	--	--	--	--
117	14	60	21	--	17	--	--	--	--	--	2
18	7	92	4	--	2	--	--	3	--	--	--
Middle member											
JS-63-85	66	64	18	--	3	4	--	12	--	--	--
86	66	62	7	--	--	4	--	25	--	--	2
100	21	79	8	7	--	1	--	6	--	--	--
101	21	78	14	--	7	1	--	--	--	--	--
115	14	74	9	4	--	--	--	13	--	--	1
116	14	94	3	--	--	--	--	2	--	--	1
Lower member											
JS-63-84	66	76	13	--	4	6	--	1	--	--	--
JS-64-147	57	68	1	--	3	--	--	1	--	27	--
148	57	70	--	--	22	--	--	2	--	5	1
149	57	81	--	--	12	--	2	5	--	1?	--
151	57	58	--	--	6	--	--	7	--	29	--
JS-65-20	14	94	3	--	1	--	--	2	--	--	--

[1] Includes quartz overgrowths and minor amounts (<2 percent) of quartzite and chert.
[2] In middle member probably some of muscovite is altered feldspar or argillite fragments that cannot be differentiated from matrix of rock.
[3] Trilobite fragments composed of carbonate minerals stained with limonite.

EXPLANATION OF FIGURE 15

Isopach map of the Wood Canyon Formation and correlative strata showing resultant dip directions of cross-strata. Strata at localities 1, 45, and 51 are the Deep Spring, Campito, and Poleta Formations; strata at localities 37 and 42 are the Tapeats Sandstone; strata at localities 68 and 69 are part of the Prospect Mountain Quartzite.

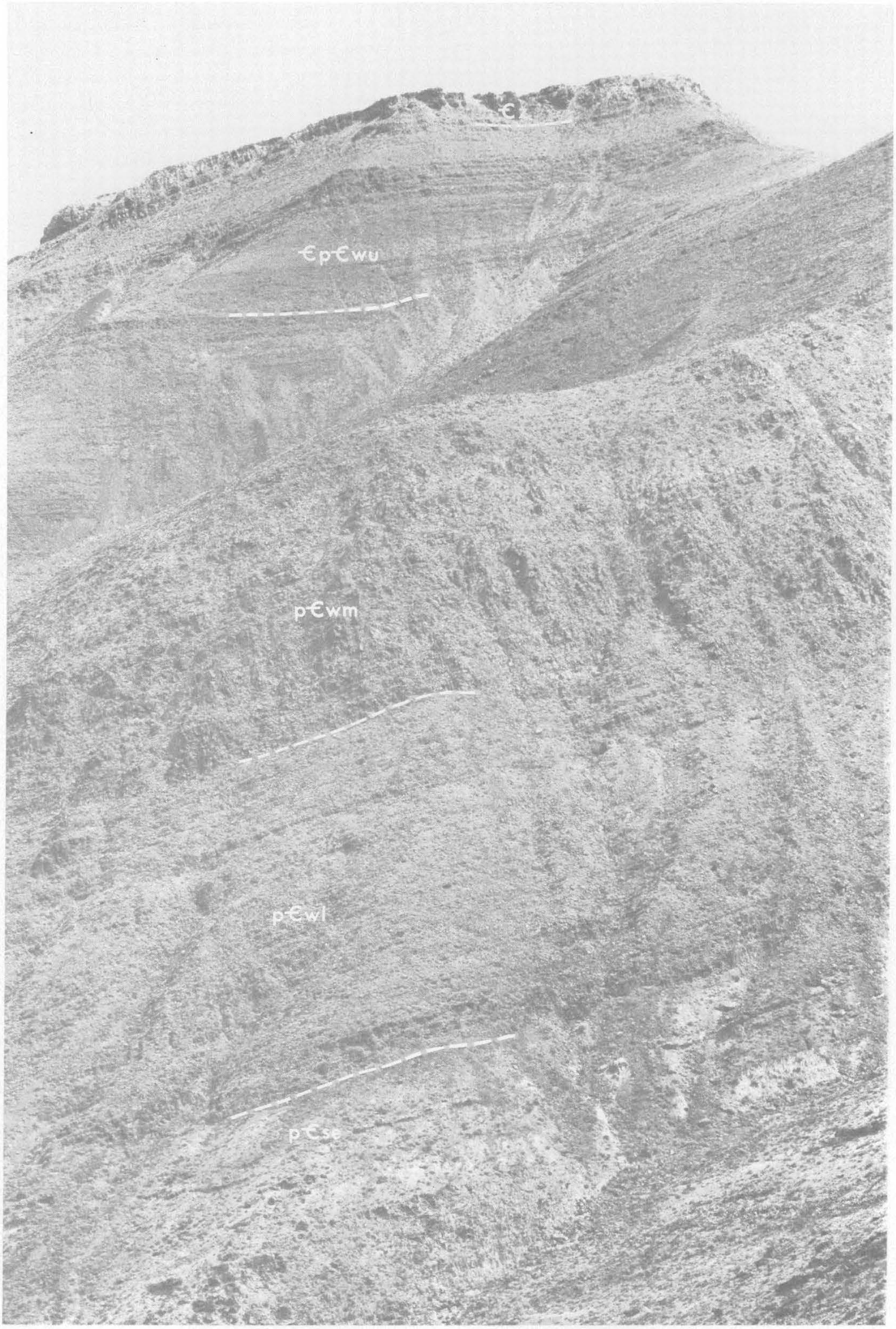


FIGURE 16.—(See left column of facing page for explanation.)

TABLE 9.—*Thickness, in feet, of Wood Canyon Formation and its members*

[Symbols used: nm=not measured; 0=absent]

Locality	Locality No. (fig. 2)	Wood Canyon Formation (*incomplete)	Lower member (*incomplete)	Middle member	Upper member
Northeast part of Clark Mountains	37	[1] 170	0?	[1] 170	0?
Marble Mountains	42	[1] 414	0	[1] 320	[1] 94
Providence Mountains	41	638	0	447	191
Northwest of Kelso	40	nm	102	nm	nm
Las Vegas Range	73	673	0	523	150
Silurian Hills	35	1, 100	0	505	595
Silver Lake	38	* 273	49	nm	nm
Salt Spring Hills	33	1, 320	43	720	557
Winters Pass	32	1, 678	0	1, 084	594±
Winters Pass Hills	31	nm	47	nm	nm
Desert Range	71	2, 031	443	1, 057	531
Nopah Range	26	2, 071	230	1, 135	706
Horse Springs	66	2, 252	698	925	629
Trail Canyon	14	2, 275	513	948	814
Northern part of Resting Spring Range	21	2, 277	662	859	756
Groom district	67	2, 285	535	1, 005	745
Bare Mountain	57	3, 747	1, 413	849	1, 485
Titanothere Canyon	8	* 3, 279	* 1, 139	570	1, 570
Belted Range	55	3, 750	1, 320	1, 117	1, 313
Echo Canyon	11	3, 950	1, 274	1, 661	1, 015

[1] Strata assigned to the Tapeats Sandstone but equivalent to the Wood Canyon Formation and its members.

MIDDLE MEMBER

The middle member forms a thick resistant part of the Wood Canyon Formation and is recognized everywhere that the formation itself is recognized.

The middle member is composed of sandstone and quartzite, some conglomerate and conglomeratic quartzite, and minor amounts of siltstone. The sandstone and quartzite are pale red to grayish red, are fine to coarse grained, and are commonly cemented tightly by quartz. They are composed of rounded to subrounded grains of quartz, a few percent to as much as 23 percent feldspar, and a few percent to as much as 25 percent interstitial muscovite (fig. 18). They include quartz arenite, quartz wacke, feldspathic arenite, and feldspathic wacke. Some of these rocks are relatively low in SiO_2 and high in Al_2O_3 as compared with other rocks in the central region (table 6). They are the most feldspathic and the most clay-rich of the fine- to coarse-grained rocks in the Precambrian and Cambrian sequence.

The sandstone and quartzite in the middle member are conspicuously cross-stratified (fig. 19), and both tabular planar and trough sets of cross-strata occur. The tabular planar sets are generally ½–2 feet thick, and individual sets have been traced for about 100 feet along the outcrop in the direction of dip of the cross-strata. In places, tabular planar sets occur one on top of another, but in other places an individual set occurs by itself (figs. 20, 21) and is separated from other cross-stratified sets by horizontally stratified siltstone or silty sandstone. The trough sets are generally about ½–1 foot thick and occur one on top of another. Thin chips or fragments, half an inch to about 2 inches across in maximum diameter and composed of locally derived siltstone or silty sandstone, commonly occur at the base of the cross-stratified sets of sandstone and quartzite. Studies at 22 localities show that the direction of dip of cross-strata in the middle member is westerly, although the resultant directions in this unit are more variable than those in other upper Precambrian and Lower Cambrian units.

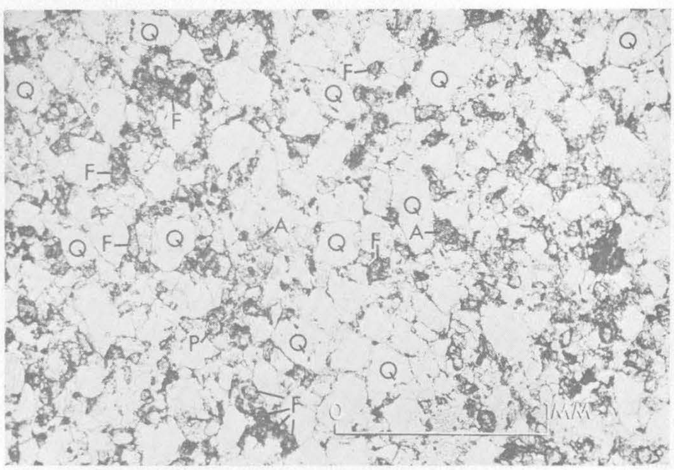


FIGURE 17.—Photomicrograph of feldspathic arenite in the lower member of the Wood Canyon Formation. Composed of subangular grains of quartz (Q), K-feldspar (F), plagioclase (P), and argillite fragments (A) tightly cemented by quartz. K-feldspar is stained, using sodium cobaltinitrite. Sample JS–63–84, loc. 66. Plane light.

EXPLANATION OF FIGURE 16

Stirling Quartzite, Wood Canyon Formation, and Zabriskie Quartzite, southern part of Nopah Range (loc. 26), Calif. Units are: pꞒse, E member of Stirling Quartzite; pꞒwl, lower member of Wood Canyon Formation; pꞒwm, middle member of Wood Canyon Formation; ꞒpꞒwu, upper member of Wood Canyon Formation; Ꞓz, Zabriskie Quartzite.

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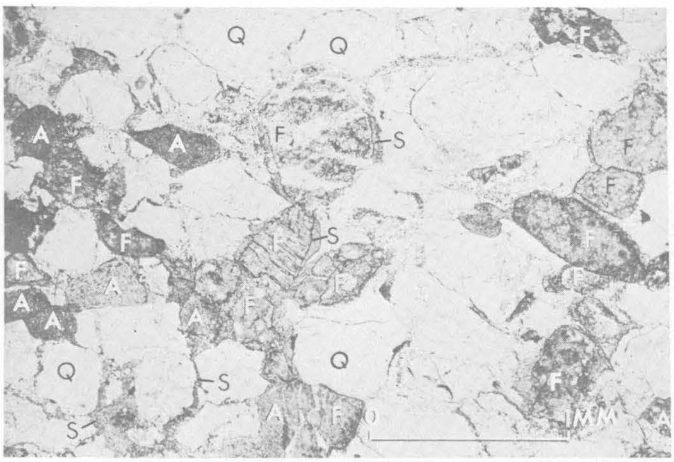

FIGURE 18.—Photomicrograph of feldspathic arenite in the middle member of the Wood Canyon Formation. Composed of quartz (Q), K-feldspar (F), argillite fragments (A), and interstitial sericite (S). Contains about 18 percent K-feldspar and 3 percent plagioclase (not shown). K-feldspar is stained, using sodium cobaltinitrite. Sample JS–63–85, loc. 66. Plane light.

Conglomerate and conglomeratic quartzite occur predominantly in the lower few hundred feet of the middle member of the Wood Canyon Formation. The gravel fragments are quartz, quartzite, and rarely chert and are generally less than half an inch in maximum diameter, although some as large as 2 inches were noted locally.

Grayish-red and grayish-red-purple horizontally laminated micaceous siltstone occurs in layers from a few inches to several feet thick interstratified with the coarser strata in the member. Indistict vertical "worm borings" resembling *Scolithus* tubes, about a quarter of an inch across and 1 to several inches long, occur locally in the siltstone. Siltstone is more abundant in the middle member on Bare Mountain (loc. 57) and in Echo Canyon (loc. 11), and in these areas much of it is greenish gray.

The lithologic character of the middle member changes gradually upward from mostly conglomeratic quartzite and conglomerate in the lower few hundred feet (commonly the basal 200 ft) to quartzite and siltstone near the top. In general, the grain size of the quartzite and sandstone decreases upward from medium to coarse in the lower part to fine near the top. Siltstone is rare or absent in the lower few hundred feet of the member, but increases in amount upward and commonly constitutes about 25 percent of the member near the top.

The middle member ranges in thickness from a few hundred feet in the southeastern part of the southern Great Basin region to more than 1,000 feet in the western part (table 9).

UPPER MEMBER

The upper member extends throughout the same areas as the Wood Canyon Formation as a whole and is composed of siltstone, quartzite, and, in part of the upper half, dolomite and limestone. The siltstone is grayish olive, greenish gray, and moderate yellowish brown, is commonly platy, and is composed of silt-sized detrital grains of quartz and, in some samples, minor amounts of feldspar, set in a mesh of muscovite and chlorite. Trace fossils, such as worm borings along stratification planes, trilobite(?) scratches and trails, and drag marks, are common in the siltstone. In the upper half of the upper member, *Scolithus* tubes (vertical worm borings) are common in the siltstone and in the very fine to fine-grained quartzite. Minute symmetrical ripple marks (microripples) (fig. 22), from a tenth to a twentieth of an inch between crests, are common in sandy coarse siltstone in the upper member. They also occur rarely in other formations in the upper Precambrian and Lower Cambrian sequence in the southern Great Basin.

Quartzite constitutes an important amount, perhaps 40 percent, of the upper member and occurs in layers from a few inches to several feet thick interstratified with siltstone. The quartzite is yellowish gray, very fine to fine grained, and evenly laminated (fig. 23), although small-scale cross-strata occur rarely. The quartzite is composed predominantly of subangular grains of quartz and minor amounts of feldspar tightly cemented by overgrowths of quartz. The quartzite includes types classed on the basis of composition as quartz arenite, feldspathic arenite, and arkosic arenite. The feldspar content ranges from 4 percent to 38 percent in the samples studied, and both K-feldspar and plagioclase occur in most samples. Trilobites replaced by carbonate minerals (fig. 24) are common in some quartzite beds in the upper half of the member and are associated with *Scolithus* tubes, which occur in both quartzite and siltstone. The trilobite-bearing quartzite is a characteristic and distinctive feature of the upper member of the Wood Canyon Formation and can be used to identify the member where the strata have been sheared and metamorphosed in areas of complex structure.

A regionally persistent unit containing 20–60 percent carbonate occurs within the upper half of the upper member. This unit is generally 50–150 feet thick, and its top lies from 50 to 150 feet below the top of the member. In most areas, the carbonate material is almost entirely dolomite and occurs in layers a few inches to several feet thick. It is medium gray on fresh surfaces, but weathers a characteristic moderate yellowish brown. Many of the dolomite layers are oolitic and contain a minor amount of detrital quartz that ranges in grain size from coarse silt to very fine sand. Pelmatozoan debris consisting of disk-shaped pieces of dolomite that are 1–2 mm in diameter is abundant in many of the dolomite layers (identified by A. R. Palmer, written commun., 1962). The oolitic structures and the pelmatozoan debris are highly distinctive features of the upper member of the Wood Canyon Formation.

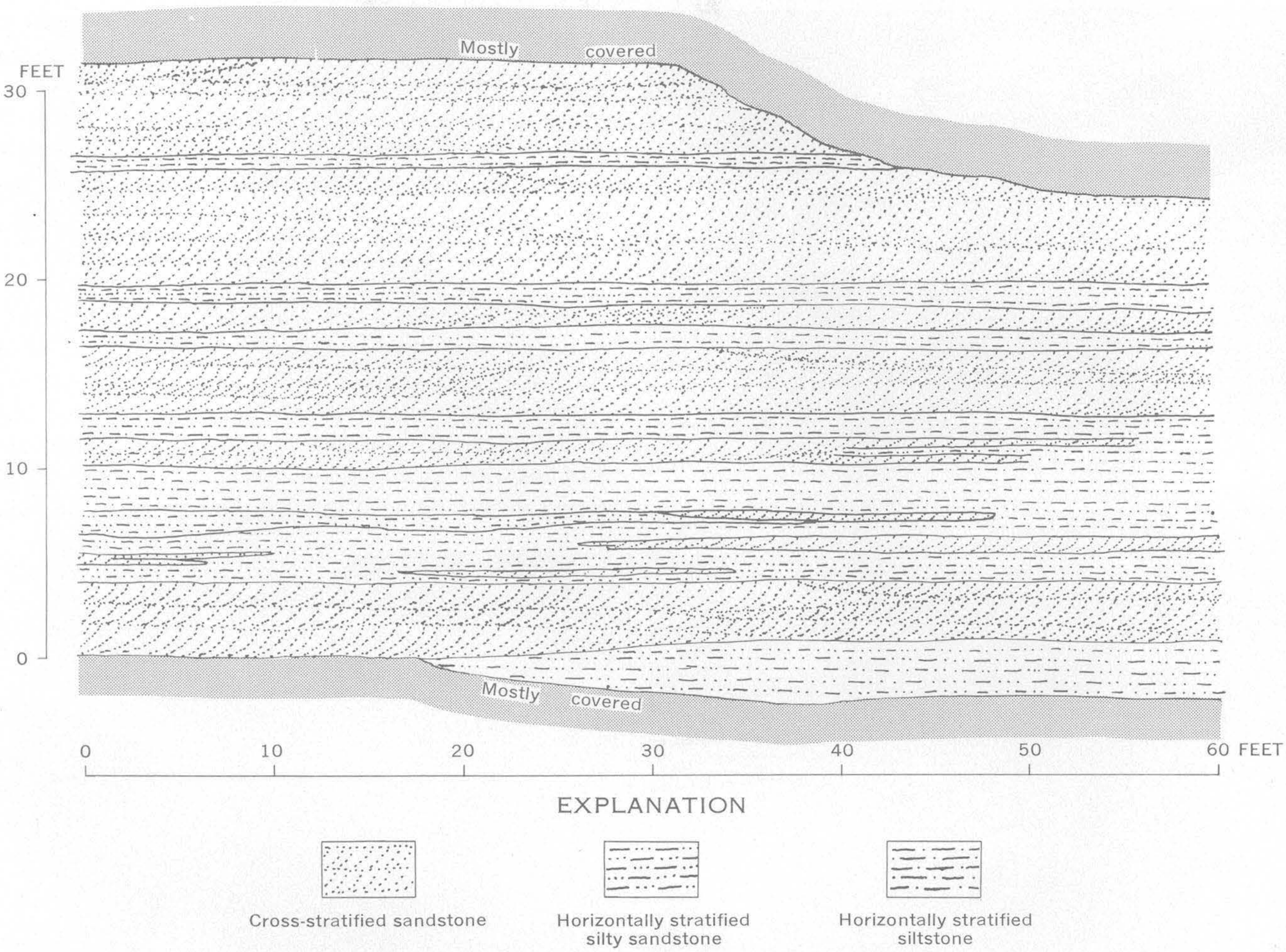

FIGURE 19.—Stratification in the middle member of the Wood Canyon Formation, Kingston Range area, California, sec. 22 (unsurveyed), T. 20 N., R. 11 E.

The lithologic character and the thickness of the carbonate-bearing unit of the upper member are different in the northwestern part of its area of distribution, which includes the Funeral and Grapevine Mountains area (locs. 8, 11), Bare Mountain (loc. 57), and the southern part of the Last Chance Range, loc. 7). In these areas, the unit is 500–800 feet thick, and most of the carbonate is medium-gray and pale-yellowish-brown limestone. At the base of the unit in these areas is a limetsone bed, 30–125 feet thick, that locally contains some siltstone. Archeocyathids have been found in this limestone bed in the Funeral and Grapevine Mountains (J. F. McAllister, written commun., 1963; M. W. Reynolds, written commun., 1963; and Hunt and Mabey, 1966, p. A23), on Bare Mountain (Cornwall and Kleinhampl, 1964, p. J2), and in the southern part of the Last Chance Range (Stewart, 1964, p. A69). The upper half of the carbonate-bearing unit in these areas contains abundant *Scolithus*-bearing quartzite as well as limestone and siltstone. The carbonate-bearing unit in the northwestern part of its area of distribution is lithologically and faunally similar to the Poleta Formation of the western region, with which it is correlated. (See description under "Poleta Formation.")

The upper member ranges in thickness from less than 100 feet in the eastern and southeastern part of the central region of the southern Great Basin to more than 1,000 feet in the northwestern part.

Siltstone and quartzite in the upper part of the upper member contain the lowest trilobites discovered in strata of the central region. The most common trilobite is a nevadiid that does not fit into any described genus, although it resembles *Judomia,* a Siberian genus (A. R. Palmer, written commun., 1963). This form, which has previously been called *Wanneria*? *gracile* Walcott (Hazzard, 1937a, p. 312) and "*Nevadella gracile*? (Walcott)" (Hunt and Mabey, 1966, p. A23), occurs in the first 100 feet or so of strata below the carbonate-bearing unit. Another trilobite, *Nevadella* cf. *N. addeyensis* (Okulitch), occurs in the lower part of the carbonate-bearing unit in the Daylight Pass area between the Grapevine and Funeral Mountains (C. A. Nelson,

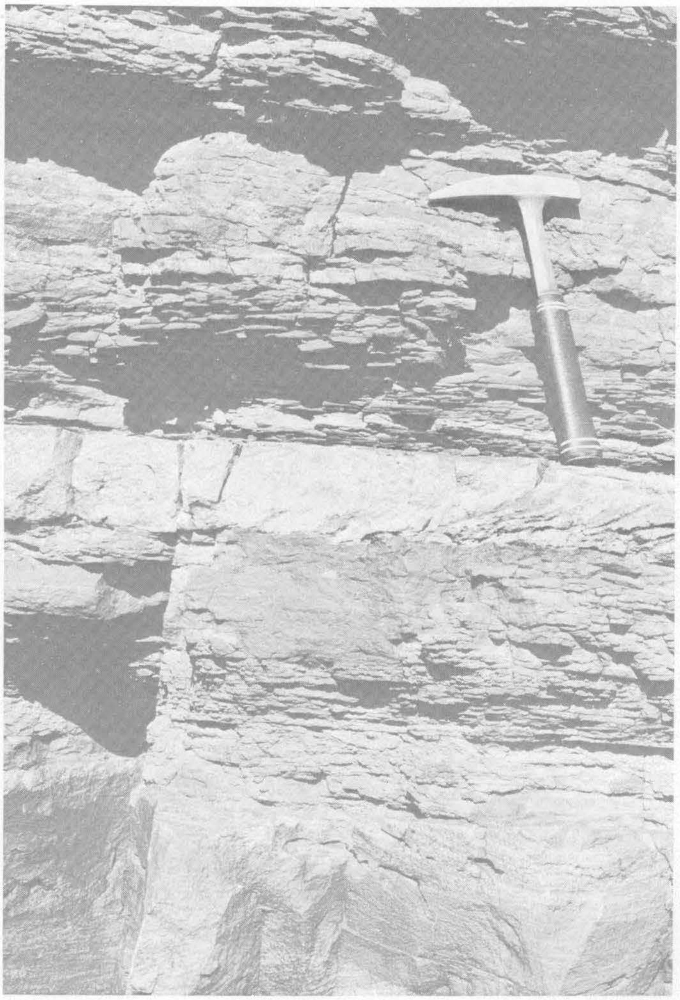

FIGURE 20.—Cross-stratified set of medium- to coarse-grained quartzite between horizontally stratified siltstone and silty sandstone in the middle member of the Wood Canyon Formation, Kingston Range area, California, sec. 22 (unsurveyed), T. 20 N., R. 11 E.

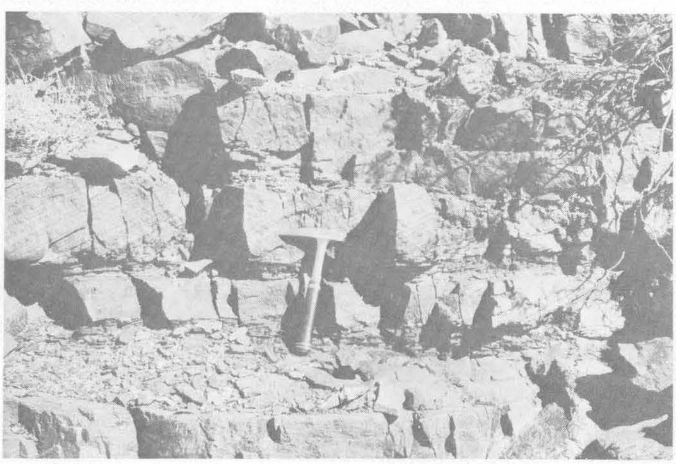

FIGURE 21.—Interstratified sets of cross-stratified fine- to medium-grained quartzite and horizontally stratified siltstone and silty sandstone in the middle member of the Wood Canyon Formation, Kingston Range area, California, sec. 22 (unsurveyed), T. 20 N., R. 11 E.

oral commun., 1966). The trilobites in the member are Early Cambrian in age (A. R. Palmer, written commun., 1963). Brachiopods (Hazzard, 1937a, p. 309, 312; Hunt and Mabey, 1966, p. A22), *Hyolithes* (Hazzard, 1937a, p. 312), and, as mentioned above, archeocyathids, pelmatozoan debris, and *Scolithus* tubes also occur in the upper part of the upper member.

ZABRISKIE QUARTZITE

The Zabriskie Quartzite, which is assigned an Early Cambrian age on the basis of its stratigraphic position, is recognized in an area of about 15,000 square miles in the central region of the southern Great Basin (pl. 3*c*; fig. 25). It consists of dense light-colored cliff-forming quartzite that contrasts with the underlying darker colored, more silty, and in part slope-forming Wood Canyon Formation; it also con-

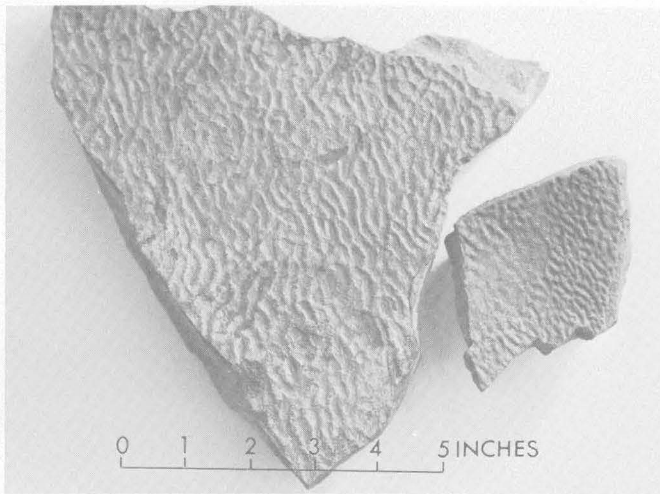

FIGURE 22.—Microripples in very fine grained quartzite in the upper member of the Wood Canyon Formation. Specimen on left is from Echo Canyon, Calif. (loc. 11); specimen on right is from southern part of Last Chance Range, Calif. (loc. 7).

FIGURE 23.—Evenly laminated very fine grained quartzite in the upper member of the Wood Canyon Formation, Trail Canyon (loc. 14), Panamint Range, Calif.

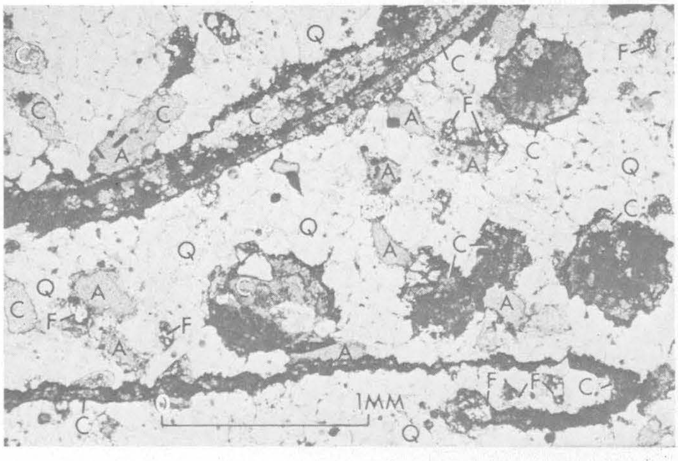

FIGURE 24.—Photomicrograph of quartz arenite containing trilobite debris, upper member of the Wood Canyon Formation. Composed of subangular grains of quartz (Q), K-feldspar (F), and argillite fragments (A). Tightly cemented by quartz. Carbonate mineral (C) occurs in fossil debris and in grains. Large iron-stained fragments composed of carbonate are trilobites; rounded iron-stained fragments may be pelmatozoan debris. K-feldspar is stained, using sodium cobaltinitrite. Sample JS–63–89, loc. 66. Plane light.

trasts with the overlying Carrara Formation and related strata, which are composed predominantly of slope-forming siltstone and limestone. The Zabriskie forms a westward-thickening wedge of sedimentary rock that is more than 1,000 feet thick in the western part of the central region. In the western region, correlative strata are more than 2,000 feet thick and consist of fine-textured strata that constitute the main part of the Harkless Formation and the lower part of the overlying Saline Valley Formation.

The Zabriskie was named by Hazzard (1937a, p. 309–310), and he considered it to be a member of an expanded (by Hazzard) Wood Canyon Formation; it was later raised to the rank of a formation by Wheeler (1948, p. 26) and by Barnes, Christiansen, and Byers (1965). The Zabriskie, as described here, includes the uppermost part of the unit called Prospect Mountain Quartzite by Hewett (1956) in the Kingston Range area and the western part of the Clark Mountain area, and the uppermost part of the unit called Tapeats Sandstone (Hewett, 1956) or Prospect Mountain Quartzite (Hazzard, 1954, p. 30) in the Providence Mountains. The reasons for these reassignments have been discussed previously. (See description under "Eastern region" and "Johnnie Formation".)

Strata that are considered here to be equivalent to the Zabriskie Quartzite are also recognized within the top of the Tapeats Sandstone in the eastern part of the Clark Mountain area (loc. 37) and in the Marble Mountains (loc. 42). Correlative strata are also recognized at the top of what is called Prospect Mountain Quartzite (Callaghan, 1937, p. 15–17; Merriam, 1964, p. 9–13) at Delamar (loc. 68) and Pioche (loc. 69). These correlative strata are shown on the isopach maps and the stratigraphic diagrams (pl. 3*c*; fig. 25).

The Zabriskie Quartite, as defined by Hazzard (1937a, p. 309–310 and fig. 3d), includes some fine-grained quartzite and siltstone strata that are transitional into the underlying Wood Canyon Formation, but does not include Zabriskie-like strata near the base of the overlying Carrara Formation. Such a definition is followed in this report, although a more logical definition might have been to include with the Zabriskie those Zabriskie-like units above the main part of the unit as well as those below. The main reason for continuing to use Hazzard's definition is that the original usage, which has been followed by subsequent workers, is retained. In the type locality of the Wood Canyon Formation (near loc. 66, in strat. sections), no transitional strata occur between the Wood Canyon and Zabriskie, so Hazzard's definition of the Zabriskie does not conflict with the definition of the Wood Canyon. In addition, the definitions of the Zabriskie and the overlying Carrara Formation are compatible, because Zabriskie-like strata are included in the basal part of the Carrara Formation, as defined by Cornwall and Kleinhampl (1961; 1964, p. J4 and pl. 2), and correlative strata are excluded from the type Zabriskie, as defined by Hazzard.

The Zabriskie Quartzite is composed predominantly of pinkish-gray fine- to medium-grained vitreous cliff-forming quartzite (fig. 26). The grain size commonly ranges from fine to coarse, and the rock, when examined with a hand lens, appears to have a bimodal grain size distribution, although in thin section the rock is seen to be a mixture of several grain sizes. The rock is composed almost entirely of quartz which occurs as rounded grains and overgrowths in a tight mosaic (fig. 27). A few grains of zircon and tourmaline and some muscovite occur, but such impurities are very minor and do not affect the classification of the rock, which is a quartz arenite that averages about 97 percent SiO_2 (table 6). This is the highest silica content of any unit in the upper Precambrian and Lower Cambrian sequence.

Stratification is difficult to see in much of the Zabriskie, but the formation is characteristically composed of shallow trough sets of small-scale cross-strata. These sets are generally only a few inches thick, and the cross-strata dip 10° or less. No studies of dip direction were made in these low-angle cross-strata, because rarely could the exact orientation of an individual cross-stratum be determined. In a few areas, however, high-angle cross-strata occur in the lower part of the Zabriskie, and as determined by studies at four localities, this type of cross-strata dips westerly (fig. 25).

Thin conglomerate layers occur in the Zabriskie in some areas, although the total amount of conglomeratic material is extremely small, and its distribution is spotty and seemingly unpredictable. Commonly, the size of the pebbles,

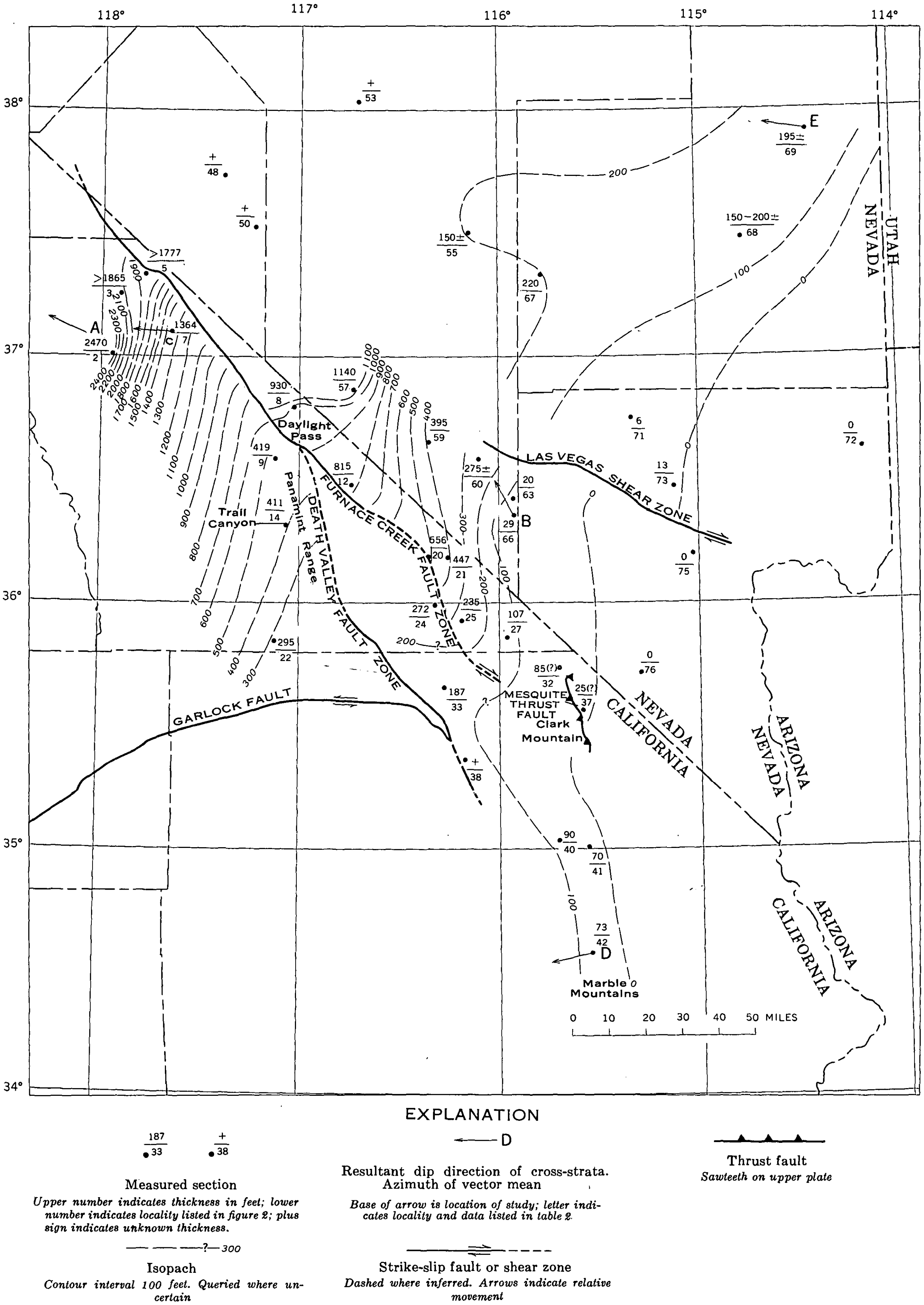

FIGURE 25.—(See left column of facing page for explanation.)

which are predominatly quartz, is fairly large; some pebbles almost 2 inches in diameter have been noted.

Vertical worm borings (*Scolithus*) (fig. 28) are common in the Zabriskie Quartzite, although their distribution is spotty. The formation contains no other fossils, but an Early Cambrian age is assured because strata both above and below the formation contain trilobites of Early Cambrian age.

The Zabriskie Quartzite ranges in thickness from less than 100 feet in the eastern part of the region to more than 1,000 feet in the western part (fig. 25).

The lower contact of the formation is commonly transitional and is difficult to define precisely. In general, however, the very fine to fine-grained quartzite and sandstone of the Wood Canyon Formation gives way upward to the dense vitreous fine- to medium-grained quartzite of the Zabriskie. Some siltstone and micaceous sandstone are interstratified with the quartzite strata near the contact. The contact is placed at the lowest occurrence of quartzite that contains, on the basis of hand specimen examination, either medium grains scattered in a fine-grained matrix or medium-grained layers. Such a definition requires careful examination of the stratigraphic sequence, but the criteria cited seem to define the contact fairly closely.

In the eastern part of the region (loc. 66, 71, 73), the Zabriskie Quartzite rests with a sharp contact on the underlying Wood Canyon Formation; no transitional strata occur. The contact is so abrupt in places that a stratigraphic hiatus or erosional surface is suggested, although no physical evidence of erosion was noted.

The top contact of the Zabriskie Quartzite is placed at the base of the lowest occurrence of siltstone, phyllitic siltstone, or shale above the massive vitreous quartzite of the Zabriskie. This contact is sharp and well defined (fig. 26), although some Zabriskie-like quartzite occurs from a few feet to a few tens of feet above this contact.

CARRARA FORMATION AND EQUIVALENT STRATA

The Carrara Formation (named by Cornwall and Kleinhampl, 1961), which is assigned an Early and Middle Cambrian age on the basis of trilobite fossils, extends throughout much of the central region of the southern Great Basin. It consists largely of siltstone and carbonate and is transitional between the generally quartzite sequences below and the relatively clean carbonate sequences above. Correlative strata in the eastern region of the southern Great Basin form part or all of the Bright Angel Shale (Lower and Middle Cambrian). Correlative strata in the western region consist of the upper part of the Saline Valley Formation (Lower Cambrian), the Mule Spring Limestone (Lower Cambrian), and the Monola Formation (Middle Cambrian) or the laterally equivalent lower part of the Emigrant Formation (Middle and Upper Cambrian). The Carrara and equivalent strata in the central region have not been studied thoroughly by the writer, and only a short description, mainly of the lower part of the sequence, is included.

The Carrara Formation is a heterogeneous sequence of olive-gray and greenish-gray siltstone and shale and medium-gray limestone in the lower half and medium-gray limestone and yellowish-brown silty limestone and limy siltstone in the upper half (Cornwall and Kleinhampl, 1961, 1964, p. J4–J5; Barnes and others, 1962; Stewart, 1965, p. A70; Barnes and Christiansen, 1967). The formation is generally about 1,300–2,000 feet thick. Abundant trilobite remains show that about the lower third of the formation is Early Cambrian and the upper two-thirds is Middle Cambrian.

The lower 60–130 feet of the Carrara Formation contains quartzite that is lithologically similar to the underlying Zabriskie Quartzite. Throughout most of the northern, central, and southern Death Valley areas and some adjacent localities (locs. 7, 9, 12, 14, 20, 21, 24, 57), this part of the formation consists of a lower unit about 10–45 feet thick composed of olive-gray, greenish-gray, or dusky-yellow siltstone, sandy siltstone, and small amounts of sandstone and limestone, and an upper unit, about 20–60 feet thick, composed of fine- to medium-grained quartzite that is lithologically similar to the Zabriskie Quartzite. The quartzite unit forms a distinctive white band (fig. 26) near the base of the Carrara Formation and is visible from several miles away. In all the outcrops examined, some of which extend for several miles, this quartzite is continuous and lithologically homogeneous. The observed continuity and the similar stratigraphic sequence in all the areas where the unit was observed leave little doubt that the unit is everywhere the same. Conservatively, the unit probably covers an area of more than 2,000 square miles, extending about 80 miles in a north-south direction and 30–40 miles in an east-west direction.

In the northern part of the southern Great Basin region (locs. 67, 71, 73), however, the twofold division of the clastic strata in the lower part of the Carrara Formation is not recognized, although apparently correlative clastic strata do occur above the Zabriskie. These correlative strata consist of interstratified siltstone, shale, and very fine- to medium-grained quartzite, some of which is similar to that in the Zabriskie.

In the southern part of the region, clastic strata that are correlative with those at the base of the Carrara occur in the western part of the Kingston Range area (loc. 27) and in the Salt Spring Hills (loc. 33), but their recognition south of those areas is uncertain. The clastic strata may grade

EXPLANATION OF FIGURE 25

Isopach map of Zabriskie Quartzite and correlative strata showing resultant dip directions of cross-strata. Localities 2, 3, 5, 7, 48, 50, and 53 consist of strata of the Harkless and Saline Valley Formations; localities 37 and 42, of strata of the Tapeats Sandstone; localities 68 and 69, of part of the Prospect Mountain Quartzite. All other localities are Zabriskie Quartite.

FIGURE 26.—Wood Canyon Formation, Zabriskie Quartzite, and Carrara Formation, Trail Canyon (loc. 14), Panamint Range, Calif. Units are Ꞓwu, upper member of the Wood Canyon Formation; Ꞓz, Zabriskie Quartzite; Ꞓc, Carrara Formation. Note persistent thin light-colored quartzite layer near base of the Carrara Formation.

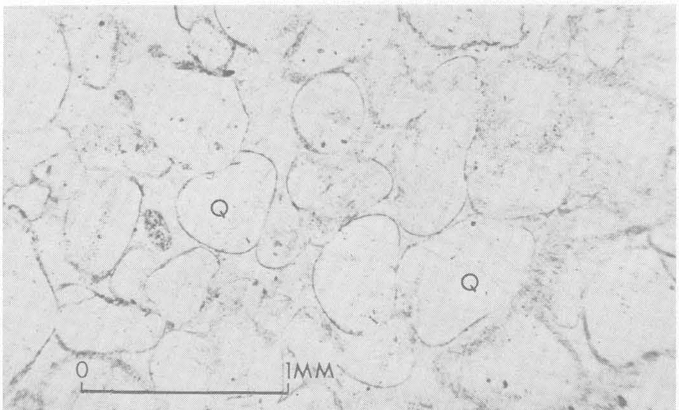

FIGURE 27.—Photomicrograph of quartz arenite in the Zabriskie Quartzite. Rounded grains of quartz (Q) tightly cemented by secondary overgrowths of quartz. Films of sericite occur around original grains. Sample JS–61–28, near loc. 66. Plane light.

laterally southward into siltstone of the overlying formation, or they may merge with and become indistinguishable from the underlying Zabriskie. The problem of correlation is particularly puzzling at Winters Pass (loc. 32), where 85 feet of Zabriskie-like quartzite, containing some *Scolithus,* is interstratified with greenish-gray and grayish-red siltstone. Some of this 85-foot interval may be Zabriskie, but how much is uncertain. Alternatively, some of or all the strata may be correlative with the clastic strata at the base of the Carrara Formation.

In the southern part of the central region, strata that are laterally equivalent to the Carrara Formation consist of three conformable formations—the Latham Shale and Chambless Limestone of Early Cambrian age and the Cadiz Formation of Early and Middle Cambrian age. These formations were named and described (Hazzard and Mason, 1936; Hazzard, 1938; Hazzard, 1954) in the Marble and Providence Mountains areas of California in the southernmost part of the southern Great Basin. The Latham Shale is about 100 feet thick or less and consists of greenish-gray platy siltstone and shale; the overlying Chambless Limestone is generally 100–200 feet thick and consists of medium-gray limestone containing abundant concretionary algal structures (*"Girvanella"*); the Cadiz Formation is about 600 feet thick and consists of yellowish-brown silty limestone and greenish-gray

FIGURE 28.—*Scolithus* (vertical worm borings) in the lower part of the Zabriskie Quartzite, Daylight Pass area, California. Photograph by H. R. Cornwall and F. J. Kleinhampl.

and grayish-red siltstone. These formations can be recognized as far north as Salt Spring Hills (loc. 33) and Winters Pass (loc. 32), Calif., but north of there, where laterally equivalent strata are assigned to the Carrara Formation, they are indistinguishable, or are distinguishable only with extreme difficulty, from other strata in the same general sequence.

The Carrara Formation and equivalent strata contain abundant trilobites belonging to several faunal zones ranging in age from Early Cambrian to early Middle Cambrian (Barnes and others, 1962, p. D27–D30; Barnes and Palmer, 1961; A. R. Palmer, oral commun., 1965). The lowest of these zones occurs in the lower 50–100 feet of the Carrara Formation and in the laterally equivalent Latham Shale and is characteried by *Bristolia,* a distinctive olenellid trilobite with advanced spines.

WESTERN REGION

The upper Precambrian and Lower Cambrian strata in the western region of the southern Great Basin consist of siltstone, limestone, dolomite, very fine to fine-grained quartzite, and rare amounts of fine- to medium-grained quartzite. They are finer grained and more carbonate-rich than correlative strata to the east in the central and eastern regions of the southern Great Basin. The base of the section in the western region is nowhere exposed, but the minimum thickness in the White and Inyo Mountains area is about 21,000 feet (Nelson, 1962).

The nomenclature of the western region is entirely different from that of the central region. Owing to facies changes across the southern Great Basin, the formations of the central region cannot be mapped (except locally) in the western region, even though physically correlative strata are recognized. The nomenclatural change is thus a practical necessity. The boundary between the central and western regions separates strata on the west that resemble formations defined in the White and Inyo Mountains of the western region from strata on the east that resemble formations defined in the Spring Mountains–Death Valley area of the central region. This boundary is easily drawn along much of its extent, and only in the Last Chance Range area do strata characteristic of the two regions crop out close together. In this area, the boundary is drawn on the basis of facies in the Zabriskie Quartzite and laterally equivalent parts of the Harkless and Saline Valley Formations. In or near outcrops where the Zabriskie interval is a massive quartzite unit and thus resembles typical Zabriskie, the nomenclature of the central region is used; where the Zabriskie interval contains many or numerous siltstone layers and is thus unlike typical Zabriskie, but is similar to the Harkless and Saline Valley Formations, the nomenclature of the western region is used.

The upper Precambrian and Lower Cambrian strata of the western region are divided into eight formations, which are, in ascending order, the Wyman Formation, Reed Dolomite, Deep Spring Formation, Campito Formation, Poleta Formation, Harkless Formation, Saline Valley Formation, and Mule Spring Limestone. These formations have been mapped and described by Nelson (1962; 1966a, b) and Ross (1965) in the White and Inyo Mountains, by McKee (1962), Stewart (1965), McKee and Nelson (1967), and McKee (1968), in the Last Chance Range area, and by McKee and Moiola (1962), Albers and Stewart (1962, 1965), and McKee (1968) in Esmeralda County, Nev. The writer has studied these strata most extensively in Esmeralda County, Nev., and the Last Chance Range area, California, and has only briefly studied the excellent exposures in the White and Inyo Mountains, which is an area being studied in detail by C. A. Nelson. A more detailed description of the upper Precambrian and Lower Cambrian strata in Nevada will appear in a report on the geology of Esmeralda County, Nev., presently being prepared by J. P. Albers and J. H. Stewart.

WYMAN FORMATION

The Wyman Formation of late Precambrian age is several thousand feet-thick and consists largely of fine-textured phyllitic strata and carbonate. It is the oldest formation exposed in the western region and is overlain by the lithologically contrasting carbonate and clastic sequence of the Reed Dolomite. The Wyman may be a fine-textured lateral equivalent of the Johnnie Formation and the lower part of the Stirling Quartzite of the central region of the southern Great Basin, but these correlations, as described below, are uncertain.

The Wyman Formation was named by Maxson (1934, p. 311; 1935, p. 314) for outcrops in the White Mountains and was redefined by Nelson (1962, p. 140) to include strata considered by Maxson to unconformably underlie the Wyman. Mapping by Nelson indicated that no unconformity separates the Wyman and the underlying strata and that no persistent division within the formation is possible at present.

The Wyman is widely exposed in the White and Inyo Mountains, Calif., and in Esmeralda County, Nev. It is composed of phyllitic siltstone, phyllitic silty claystone and minor amounts of limestone, dolomite, sandy limestone, limy siltstone, and limy very fine-grained sandstone. The strata are somewhat metamorphosed everywhere and commonly grade into phyllite, schist, marble, and calc-silicate and siliceous hornfels. The phyllitic siltstone is medium gray, olive gray, or dark greenish gray and is composed of silt-sized quartz particles mixed with fine-textured biotite, chlorite, and muscovite. An original fine lamination is noticeable locally in the phyllitic siltstone, but the original stratification is generally obliterated by a secondary cleavage that is commonly at an angle to the stratification.

Interlayed with the phyllitic siltstone are units of laminated limestone or marble that rangle from less than an inch to 20 feet in thickness but that are locally at least 50 feet thick. Some of these limestone units are oolitic or pisolitic, and some contain limestone pellets. Some of the pisolitic structures may be algal. Dolomite layers also occur in the Wyman, but many of them can be traced laterally into limestone and appear to have been formed by alteration of limestone.

Layers of sandy limestone and limy sandstone, ¼–8 inches thick, are interstratified with the phyllitic siltstone. These layers are light to medium gray, are yellowish brown weathering, are distinctly and evently laminated, and are composed of very fine grains of quartz and minor amounts of feldspar set in a calcite matrix. Orthoclase grains appear to constitute 10–15 percent of some of these rocks. Plagioclase is present also, but in very minor amounts.

The Wyman Formation is many thousands of feet thick. Nelson (1962, p. 140) reported a minimum thickness of 9,000 feet, and the base of the formation is not exposed in the Inyo Mountains. The formation may be about the same thickness in Esmeralda County, although the formation is highly faulted and only 1,350 feet (fig. 29) has been measured in any one continuous exposure.

To correlate the Wyman Formation with strata to the southeast in the central region of the southern Great Basin is difficult because outcrops of possibly correlative strata lie 35 or more miles apart, and because conspicuous facies changes occur even in the closest outcrops in the central region. The most likely possibility is that the Wyman Formation can be correlated with the A, B, and C members of the Stirling Quartzite and possibly with part or all of the under-

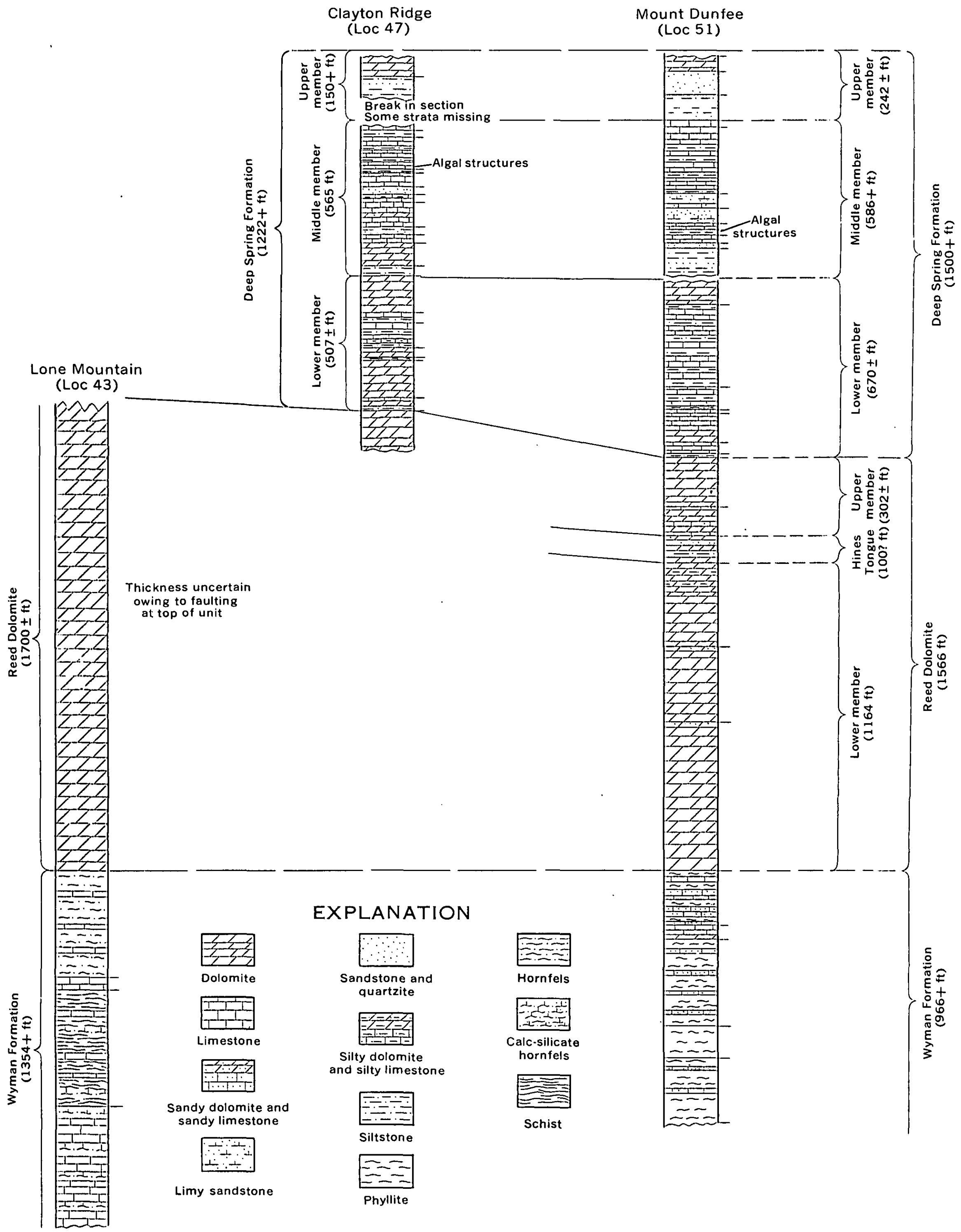

FIGURE 29.—Correlation of the Wyman Formation, the Reed Dolomite, and the Deep Spring Formation, Esmeralda County, Nev.

lying Johnnie Formation. In most of the central region, these three members of Stirling are composed predominantly of fine- to medium-grained quartzite that is unlike the Wyman, but toward the northwest in the western part of the central region they thicken and contain abundant siltstone and carbonate strata. The rate of facies changes in the lower part of the Stirling, therefore, is apparently sufficient to account for the change from the quartzite of the lower Stirling to the siltstone and carbonate of the Wyman.

The contact between the Wyman and the overlying Reed Dolomite in the White and Inyo Mountains area, California, was considered to be an unconformity by Nelson (1962, p. 140–141; 1966a, b) because of the wide lithologic variation in strata directly below the Reed, although he noted that an unconformity is difficult or impossible to demonstrate at individual outcrops. The contact was considered conformable, on the other hand, by Albers and Stewart (1962, p. D26) and McKee and Moiola (1962, p. 533) in Esmeralda County. Where the contact is well exposed on Mount Dunfee (loc. 51 in strat. sections) and on the east side of Lone Mountain (loc. 43), both in Esmeralda County, Nev., the stratification at the top of the Wyman is parallel to that at the base of the Reed. On Mount Dunfee some of the limestone in the top 250 feet of the Wyman Formation contains pellets and pisolites that closely resemble structures in the overlying Reed Dolomite, and some of the limestone in the top part of the Wyman is locally altered to dolomite that is indistinguishable from that in the lower part of the Reed Dolomite. The lithologic similarities between the strata near the top of the Wyman and the strata in the lower part of the Reed suggest a transitional sequence from the one to the other. As suggested earlier (Albers and Stewart, 1962), perhaps the wide lithologic variation in the Wyman that occurs directly beneath the Reed Dolomite in the White and Inyo Mountains is not due to an unconformity but rather to the original lenticularity of beds within the Wyman and, in some places, thrust relations between the Wyman and Reed.

REED DOLOMITE

The Reed Dolomite (named by Kirk, in Knopf, 1918, p. 24) occurs in outcrops throughout much of the White and Inyo Mountains area, California, and in scattered outcrops in Esmeralda County, Nev. It is composed largely of dolomite, but in some areas a middle quartzitic member is found. The Reed is contrasted with the fine-textured phyllitic strata of the underlying Wyman Formation and with the siltstone, quartzite, limestone, and dolomite of the overlying lithologically heterogeneous Deep Spring Formation. The Reed Dolomite is believed to be a carbonate-rich westward facies of the upper part of the Stirling Quartzite of the central region of the southern Great Basin.

The Reed Dolomite has been considered to be possibly Cambrian by Cloud and Nelson (1966), because of the presence of mollusclike fossils (Taylor, 1966) near its top. The Reed has been considered to be Cambrian or Precambrian by Nelson (1962), Precambrian(?) by Albers and Stewart (1962), and Precambrian by Kirk (in Knopf, 1918), McKee and Moiola (1962), and Stewart (1966). A Precambrian age is used here because the Reed is 2,000–3,000 feet below the lowest occurrence of olenellid trilobites and archeocyathids, fossils used as a basis for separating Precambrian and Cambrian strata elsewhere in the southern Great Basin.

The Reed Dolomite is composed mostly of white to medium-gray, yellowish-gray, and pale-yellowish-brown medium to coarsely crystalline dolomite. At most localities the dolomite appears to be structureless, but this characteristic may be largely due to structural movement that has obliterated the original bedding. On Mount Dunfee (loc. 51 in strat. sections), where the formation is well exposed, beds 1–4 feet thick are common, and laminated layers occur locally. Oolites, pisolites, and irregular pellets are common in the dolomite on Mount Dunfee and on Andrews Mountain (loc. 1). Some of these structures may be, in part, of algal origin. Other possible algal structures, which consist of irregular flattened spherical structures about half an inch across, occur in the lower part of the formation on Andrews Mountain. Small mollusclike fossils (*Wyattia*) occur in the topmost part of the Reed Dolomite and in the basal part of the Deep Spring Formation in the southernmost part of the White Mountains (Taylor, 1966; Cloud and Nelson, 1966, p. 768; Nelson and Durham, 1966, fig. 1), but no other fossils except the possible algae are known from the Reed.

A wedge of clastic material—the Hines Tongue (named by Nelson, 1962, p. 141)—occurs within the Reed Dolomite in the eastern and southeastern parts of the White and Inyo Mountains area, California, and on Mount Dunfee (loc. 51 in strat. sections) in Esmeralda County, Nev. The unit contains a variety of rock types, but the most characteristic type is yellowish-gray or very pale orange evenly laminated quartzite and calcareous sandstone, of which some is very fine to fine grained and some is fine to medium grained. Scattered coarse grains of quartz occur rarely, and K-feldspar and plagioclase are also found in these rocks (table 10). Medium-gray to pale-yellowish-brown dolomite, limestone, sandy dolomite, and sandy limestone are common in the Hines Tongue and are interstratified with the quartzite and calcareous sandstone. A minor amount of yellowish-gray to pale-yellowish-brown siltstone also occurs.

In the Inyo Mountains the Hines Tongue is a distinctive unit that is locally over 800 feet thick (Nelson, 1962, p. 141). Northward in the White Mountains area, however, the member grades laterally into an inseparable sequence of dolomite and is no longer recognizable. A similar lateral gradation northward probably occurs north of Mount Dunfee in Esmeralda County, Nev. (fig. 29), for the Hines Tongue is recognized on Mount Dunfee, but not north of that locality.

TABLE 10.—*Mineral composition, in percent, of quartzite and sandstone of formations in the western region of the southern Great Basin as determined by approximately 100 point counts*

[Dashes (--) are entered if mineral was not detected in the 100 point counts]

Sample No.	Locality No. (fig. 2)	Quartz[1]	K-feldspar	Plagioclase	Argillite fragments	Opaques	Zircon	Muscovite	Biotite	Chlorite	Carbonate minerals	Others or unknowns
Middle member of Poleta Formation												
JS-62-5	52	65	--	13	--	--	1	1	--	3	16	1
6	52	75	--	6	--	--	--	3	--	--	--	[2] 17
8	52	56	--	27	1	--	--	2	--	--	15	--
JS-63-38	4	77	--	10	--	--	--	1	--	--	12	--
39	4	28	3	--	--	1	--	--	--	--	68	--
Andrews Mountain Member of Campito Formation												
JS-62-45	45	35	3	8	--	6	1?	29	1	9	8	--
823-37J	5	41	--	4	--	5	--	28	12	10	--	--
40J	5	52	19	12	--	3	--	9	--	--	6	--
53J	(3)	20	--	1	--	8	--	46	1	24	--	--
Upper member of Deep Spring Formation												
JS-61-80	51	66	--	--	19	--	4	3	--	5	3	--
Middle member of Deep Spring Formation												
JS-61-75	51	69	--	--	--	--	--	5	--	--	25	--
76	51	57	11	9	--	--	--	2	--	18	4	1
77	51	37	21	20	--	1	--	2	--	--	19	--
Lower member of Deep Spring Formation												
JS-61-71	51	38	--	23	1	--	1	3	--	--	35	--
JS-63-50	1	64	5	7	--	--	--	1	--	--	23	--
Hines Tongue of Reed Dolomite												
JS-63-47	1	86	6	--	--	--	--	--	--	--	8	--
48	1	62	9	2	--	--	--	--	--	--	27	--
Lower member of Reed Dolomite												
JS-63-46	1	65	4	3	--	1	--	1	--	--	25	--

[1] Includes quartz overgrowths and minor amounts (<2 percent) of quartzite.
[2] 13 percent composite grains mostly of sericite (altered feldspar?) and 4 percent unidentified limonite-stained grains.
[3] Lat 37°19′, long 117°43′.

The Reed Dolomite is about 1,700 feet thick on Andrews Mountain (C. A. Nelson, written commun., 1963) and is over 1,500 feet thick on Mount Dunfee (loc. 51). A thickness of over 2,600 feet was measured east of Lone Mountain (loc. 43) in Esmeralda County, but here the top 1,000 feet may be a duplication, and the actual thickness may be only about 1,700 feet.

The Reed Dolomite can be correlated with fair confidence with the upper part of the Stirling Quartzite of the central region of the southern Great Basin. The D member of the Stirling in the Funeral Mountains, on Bare Mountain, and on Quartzite Mountain is several hundred feet thick and is composed predominantly of dolomite and limestone that are lithologically similar to carbonate rocks in the Reed. The fine-grained clastic facies of the E member of the Stirling as developed on Bare Mountain is similar to strata in the Hines Tongue, with which it is correlated.

The contact between the Reed Dolomite and the overlying Deep Spring Formation is placed at the change from the thick-bedded or structureless dolomite of the Reed to the distinctly bedded dolomite, limestone, and clastic units of the Deep Spring Formation. This contact, although in places transitional and difficult to locate precisely, is nonetheless mappable and marks a noticeable lithologic change.

DEEP SPRING FORMATION

The Deep Spring Formation (named by Kirk, in Knopf, 1918, p. 24) occurs in scattered outcrops in the White and Inyo Mountains area, in the Last Chance Range, Calif., and in Esmeralda County, Nev. It is lithologically heterogeneous as compared with the dominant carbonate lithology of the underlying Reed Dolomite and the dominant fine-grained quartzite and siltstone of the overlying Campito Formation. It is largely the westward equivalent of the lower member of the Wood Canyon Formation of the central region of the southern Great Basin.

The Deep Spring Formation has been considered as definitely Cambrian by Cloud and Nelson (1966) on the basis of trace fossils in the formation interpreted as the markings of trilobites and thus indicative of Cambrian age. The Deep Spring Formation has been considered Cambrian or Precambrian by Nelson (1962), Precambrian(?) by Albers and Stewart (1962), and Precambrian by Kirk (in Knopf, 1918), McKee and Moiola (1962), and Stewart (1966). A Precambrian age is used here because the Deep Spring is a thousand feet or more below the lowest occurrence of olenellid trilobites and archeocyathids in the stratigraphic sequence.

The Deep Spring Formation is 1,100–1,600 feet thick and is composed of siltstone, sandstone, limy sandstone, dolomitic sandstone, quartzite, sandy limestone and dolomite, limestone and dolomite. It is divided into three members that are recognized throughout the extent of the formation and that are referred to informally as the lower, middle, and upper members. These members were originally mapped and described by Nelson (1962) and have since been recognized in the Last Chance Range (Stewart, 1965, fig. 13) and in Esmeralda County, Nev. (fig. 29; McKee and Moiola, 1962; Albers and Stewart, 1962).

The lower member is composed of limestone, dolomite, and minor amounts of sandy limestone and dolomite, siltstone, and calcareous standstone and quartzite. The limestone is generally medium gray or grayish orange, finely crystalline, and very thin bedded. Some limestone layers contain very fine grains (locally fine to medium grains) of quartz, and other beds contain small irregular carbonate pellets about a quarter of an inch in diameter. The dolomite is light gray, medium gray, or very pale orange, finely to coarsely crystalline, and laminated to thick bedded. It occurs mostly near the base and at the top of the member. The dolomite near the base of the member resembles that in the underlying Reed Dolomite and represents a transitional sequence into the Reed. The dolomite at the top of the member is also lithologically similar to the Reed and forms a distinctive light-colored layer, 30 feet to over 100 feet thick, that has been recognized in much of the White and Inyo Mountains area, California (C. A. Nelson, oral commun., 1963) and in Esmeralda County, Nev. Minor constituents of the member are olive-gray and greenish-gray siltstone and very fine to fine-grained calcareous sandstone and quartzite, some of which is rich in feldspar (table 10). The lower member ranges in thickness from about 400 to 670 feet.

The middle member is composed of quartzite, calcareous sandstone, limestone, and minor amounts of siltstone and dolomite. The quartzite and the calcareous sandstone are yellowish gray, pale yellowish brown, and very light gray, very fine to fine grained, and evenly laminated or rarely cross-stratified. They range in composition from calcareous quartz arenite to arkose (table 10). The limestone is generally medium gray and very finely crystalline to finely crystalline; some parts are oolitic. Some greenish-gray, olive-gray, and very pale orange siltstone occurs in the member, and at some localities very pale orange very finely crystalline to medium-crystalline dolomite is also present. The lower three-fourths or more of the member is composed predominantly of quartzite and calcareous sandstone. Limestone is interstratified with the clastic strata in some areas, but not in others. The upper one-fourth or less of the middle member is predominantly limestone, which in many places forms a conspicuous cliff. The middle member ranges in thickness from about 350 to nearly 600 feet.

The upper member is generally about 250–350 feet thick and has a twofold division throughout its area of recognition. The lower part is 110–220 feet thick and consists of grayish-olive, greenish-gray, and medium-gray siltstone and very fine grained silty quartzite that is commonly similar in appearance to the higher Campito Formation. The upper part of the member is 50–165 feet thick and consists of medium-gray finely crystalline dolomite that is fairly well bedded or is locally massive. Some limestone is found locally in the upper part of the member.

The amount of carbonate rock in the Deep Spring Formation increases conspicuously to the north and northwest. This increase was noted by Nelson (1962, p. 141), who studied outcrops between the east flank of the White and Inyo Mountains and the west flank of the White Mountains. On the east flank the three members of the Deep Spring contain much quartzite, siltstone, and limestone, whereas on the west flank they are composed predominantly of dolomite, which was originally included in the Reed Dolomite by Kirk (in Knopf, 1918), as discussed by Nelson (1962, p. 141). The presence of the Deep Spring on the west flank of the White Mountains is fairly certain, however, for quartzite beds that mark the base of the middle and upper members persist to the west flank, although they are inconspicuous, and the threefold division of the Deep Spring is present

(Nelson, 1962, p. 141). A similar, but less spectacular, northward increase in the amount of carbonate in the Deep Spring Formation occurs in Esmeralda County between Mount Dunfee and Clayton Ridge (fig. 29).

Algal material is found in the Deep Spring Formation, and worm borings and other trace fossils are fairly common. No remains of trilobites are known, however. Biscuit-shaped algal masses (fig. 30) occur in limestone from 167 to 184 feet above the base of the middle member on Mount Dunfee (loc. 51 in strat. sections) and from 412 to 437 feet above the base of the member on Clayton Ridge (loc. 47). Worm borings that are parallel to the stratification occur rarely in the siltstone of the middle member, but are more abundant in the siltstone and silty sandstone of the upper member. A few possible animal scratches occur in siltstone in the middle member, and possible arthropod scratches, sitzmarks, and crawltracks, some assigned (Cloud and Nelson, 1966) to *Rusophycus* and *Cruziana,* are fairly common in the siltstone and silty sandstone of the upper member. A problematical fossil that is similar to *Pteridinium,* a component of an early worldwide metazoan assemblage, occurs in the middle member of the Deep Spring Formation in the White Mountains (Cloud and Nelson, 1966). The formation contains the lowest occurrences of trace fossils, or at least the lowest occurrences of an abundance of such fossils, in the western region. A small mollusklike fossil (*Wyattia*) occurs in the basal part of the Deep Spring Formation as well as in the topmost part of the underlying Reed Dolomite (Cloud and Nelson, 1966, p. 768; Nelson and Durham, 1966, fig. 1).

The Deep Spring Formation is correlated largely with the lower member of the Wood Canyon Formation of the central region (pl. 2). This correlation is firmly supported by the lithologic similarity of the units, both of which consist of interstratified quartzite, siltstone, and carbonate layers. The carbonate units at the tops of the lower, middle, and upper members of the Deep Spring Formation appear to be exactly correlative with the three carbonate units in the lower member of the Wood Canyon. In addition, the strata contain the lowest occurrences of trace fossils, or at least the lowest occurrences of abundant trace fossils, in their respective areas of recognition.

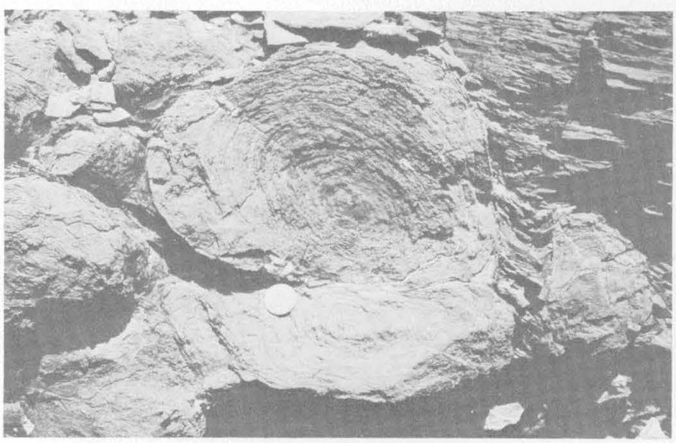

FIGURE 30.—Algal structures in the middle member of the Deep Spring Formation, Mount Dunfee (loc. 51, unit 23, in strat. sections), Esmeralda County, Nev. A 25-cent coin shows scale.

The contact of the Deep Spring Formation and the overlying Campito Formation is conformable and is marked by the change from carbonate rock below (the carbonate at the top of the upper member) to olive-gray and greenish-gray siltstone and quartzite above. The sequence of green and gray siltstone and quartzite capped by a light-colored carbonate unit is diagnostic of the upper member of the Deep Spring and thus of the top of the formation. The dark siltstone and quartzite in the upper member of the Deep Spring are, however, very similar to strata in the Campito Formation, which overlies the Deep Spring Formation, and without the presence of the intervening carbonate unit, they could not be readily distinguished from the Campito.

CAMPITO FORMATION

The Campito Formation (named by Kirk, in Knopf, 1918, p. 27) crops out extensively in the White and Inyo Mountains and the Last Chance Range area, California, and in Esmeralda County, Nev. It consists largely of very fine to fine-grained quartzite and siltstone and is contrasted with the underlying lithologically heterogeneous Deep Spring Formation and the overlying carbonate and siltstone sequence of the Poleta Formation. It is a finer grained equivalent of the middle part of the Wood Canyon Formation of the central region of the southern Great Basin. The Campito Formation is about 3,500 feet thick (Nelson, 1962, p. 141) and is divided into two members, the Andrews Mountain Member below and the Montenegro Member above, both named by Nelson (1962, p. 141).

The Campito Formation has been considered to be Cambrian by Kirk (in Knopf, 1918) and Cloud and Nelson (1966), Precambrian(?) and Early Cambrian by Albers and Stewart (1962), and Precambrian and Cambrian by McKee and Moiola (1962) and Stewart (1966). A Precambrian and Early Cambrian age is used here for the Campito because part of the Andrews Mountain Member lies below and part above the lowest occurrence of olenellid trilobites and archeocyathids in the stratigraphic sequence.

The Andrews Mountain Member is 2,500–2,800 feet thick (Nelson, 1962, p. 141) and is a homogeneous sequence of olive-gray or greenish-gray very fine to fine-grained silty quartzitic sandstone or quartzite and interbedded layers of dark-greenish-gray siltstone. The rock characteristically weathers a dark color, commonly greenish black or black, and forms rubble-covered slopes resembling those formed by basalt. The quartzitic sandstone and the quartzite are composed of subangular very fine to fine grains of quartz, feldspar, and opaque metallic minerals set in a matrix of muscovite, chlorite, and biotite (fig. 31; table 10). The matrix generally constitutes 10–40 percent of the rock. Feldspar may be an important constituent or a minor one, and most of the rocks are either quartz wacke, feldspathic wacke or arkosic wacke. Opaque metallic minerals constitute 5–10 percent of the rock, and although no study has been made of these minerals, the high iron and titania content in analyzed rocks (table 6) suggests that the main minerals are magnetite and ilmenite.

The quartzitic sandstone and the quartzite are commonly thinly laminated, although the stratification is difficult to see in most places; some contorted stratification and some cross-stratification are also found. Thin conglomeratic quartzite layers occur in the Andrews Mountain Member at a few localities. These layers contain scattered quartz granules and pebbles as large as one-fourth inch in diameter set in a fine-grained to very coarse grained matrix.

The Montenegro Member, the upper member of the Campito Formation, is 1,000 feet or less thick in the White and Inyo Mountains (Nelson, 1962, p. 141) and is about 1,000 feet thick in two measured sections in Esmeralda County, Nev. (locs. 45, 46). It consists of dark-greenish-gray and greenish-gray siltstone composed of a mixture of quartz, muscovite, and chlorite (table 4). The siltstone is evenly laminated to thin bedded, although the bedding is commonly obscured by a secondary cleavage at an angle to the bedding. Thin lenticular archeocyathid-bearing limestone beds commonly occur in the top few hundred feet of the member.

The contact of the Andrews Mountain and Montenegro Members is transitional and obscure. In a section measured

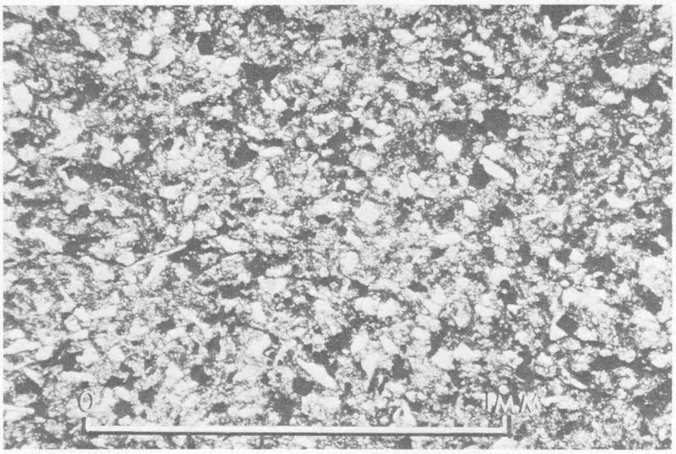

FIGURE 31.—Photomicrograph of quartz wacke in the Andrews Mountain Member of the Campito Formation. Composed of angular grains of quartz and opaque minerals (metallic in reflected light) set in matrix of muscovite and chlorite. Opaque minerals comprise about 8 percent of the rock. Sample 823–53J, Last Chance Range, Calif., long 117°43′ W., lat 37°19′ N. Plane light.

in the southern part of the Weepah Hills (loc. 45), 1,100 feet of transitional strata occur between definite Andrews Mountain and definite Montenegro. The transitional sequence is probably best assigned to the Andrews Mountain Member; by this assignment the thickness of the Montenegro Member is similar to that in the White and Inyo Mountains, where it was defined by Nelson (1962, p. 141).

The stratigraphically lowest occurrence of trilobites in the western region is in the Campito Formation; the lowest of these trilobites is *Fallotaspis,* which occurs in the middle part of the Andrews Mountain Member (Nelson and Hupé, 1964; Cloud and Nelson, 1966; Nelson and Durham, 1966, fig. 1, pl. 2). An abundant trilobite fauna (Nelson and Hupé, 1964; A. R. Palmer, written commun., 1963, 1965; Cloud and Nelson, 1966; Nelson and Durham, 1966, fig. 1, pl. 2; McKee, 1968, fig. 2, p. H8) occurs in the Montenegro Member and includes *Fallotaspis, Daguinaspis, Nevadia, Holmia* (*Esmeraldina*), and a nevadiid trilobite that does not fit into any described genus, although it resembles *Judomia.* All these trilobites are Early Cambrian in age (A. R. Palmer, written commun., 1963.) Archeocyathids are common or abundant in some of the lenticular limestone units in the upper part of the Montenegro Member (Nelson, 1962, p. 141; McKee and Gangloff, 1969). Trace fossils, such as worm borings and animal trails (Nelson and Durham, 1966, pl. 4), occur in both the Montenegro and the Andrews Mountain Members, and possible trilobite scratches and trails occur in the Montenegro Member.

The Campito Formation is correlated with the uppermost part of the lower member, the entire middle member, and the lower part of the upper member of the Wood Canyon Formation of the central region. The correlation is supported by the occurrence of Campito-like silty quartzitic sandstone or quartzite in the northwesternmost outcrops of the Wood Canyon Formation and the presence of a generally finer grained facies of the Wood Canyon Formation in these outcrops. In addition, the Campito lies between carbonate-bearing formations, the lower of which is correlated with assurance with part of the lower member of the Wood Canyon Formation and the upper of which is correlated with part of the upper member of the Wood Canyon. Finally, both formations contains the lowest occurrence of trilobites in their respective areas of outcrop, and the *Judomia*-like nevadiid trilobite occurs at the top of the supposedly correlative strata in both areas.

The contact of the Campito Formation with the overlying Poleta Formation is placed at the change from the dominant siltstone and phyllitic siltstone of the Montenegro Member to a thick sequence of limestone that is the lower member of the Poleta Formation. The limestone of the lower member of the Poleta Formation in most places contains abundant archeocyathids and is commonly oolitic.

POLETA FORMATION

The Poleta Formation (named by Nelson, 1962, p. 141–142), which is assigned an Early Cambrian age on the basis of trilobite fossils, occurs in scattered outcrops throughout the White and Inyo Mountains and the Last Chance Range area, California, and in Esmeralda County, Nev. It is one of the most distinctive formations in the upper Precambrian and Lower Cambrian sequence in the western region. It is characterized by a variety of lithologic types, an abundance of archeocyathids and trilobites, and a threefold nomenclatural division. The Poleta is composed predominantly of limestone and siltstone that contrast with the underlying very fine to fine-grained quartzite and siltstone of the Campito Formation and the overlying siltstone and local fine- to medium-grained quartzite of the Harkless Formation. The Poleta is a thicker carbonate-rich equivalent of part of the upper member of the Wood Canyon Formation of the central region of the southern Great Basin.

The Poleta Formation ranges in thickness from 850 to 1,900 feet and is divided into three members. The lower and upper members are predominantly limestone, and the middle member consists of siltstone, quartzite, and some limestone. This threefold division has previously been adopted by McKee and Moiola (1962, p. 534–535) and by Stewart (1965, p. A63; 1966, p. C71), although Nelson (1962, p. 142) originally recognized only two members in the formation. The upper member described by Nelson includes the middle and upper members of the threefold division.

The lower member is composed predominantly of medium- to light-gray oolitic limestone containing abundant archeocyathids. Most of the limestone is indistinctly thin to very thin bedded, but some units are well bedded. In most areas the lower member contains at least one unit of greenish-gray or olive-gray siltstone interstratified with the limestone. These siltstone units range in thickness from a few feet to over a hundred feet.

At the Weepah Hills, Nev., section (loc. 45 in strat. sections; see also pl. 2), strata assigned to the lower member include three units: a lower unit (140 ft thick) composed of limestone and dolomite; a middle unit (600 ft thick) composed mostly of siltstone, although covered in part; and an upper unit (330 ft thick) composed mostly of oolitic archeocyathid-bearing limestone. An alternate interpretation of the sequence at this section is that the lower two units are part of the Montenegro Member and the upper unit constitutes the entire lower member of the Poleta. This alternate assignment is not accepted, however, because elsewhere the Montenegro Member does not contain thick carbonate units.

The lower member ranges in thickness from about 120 feet in the Last Chance Range (loc. 5; Stewart, 1965, fig. 14) and on the west side of Eureka Valley (loc. 3) to over 1,000 feet in the Weepah Hills section, where, however, as mentioned above, an alternate assignment of the strata can be made. In the White and Inyo Mountains, the member is generally about 600 feet thick.

The middle member is consistently about 600–700 feet thick and is composed of three main lithologic types: siltstone, shale, and phyllitic siltstone; limestone; and sandstone or quartzite. These three lithologic types are closely interstratified.

The siltstone, shale, and phyllitic siltstone, which are the dominant lithologic types in the middle member, are grayish olive, pale olive, and locally pale yellowish brown or light brown and are composed of subangular silt-sized grains of quartz in a fine-textured mesh of muscovite, or mica clay, and chlorite (table 4).

The limestone of the member is medium gray and, to a lesser extent, grayish orange or mottled gray and light brown and is aphanitic to medium crystalline. It is in layers from less than 1 inch to 15 feet thick interstratified with the siltstone. The member in most places contains one or two limestone beds 1–15 feet thick that weather to a gray, almost blue, color and form ledges.

The sandstone and quartzite beds occur predominantly in the upper third of the middle member and are pale brown, light brown, and very pale orange, very fine to fine grained, and generally evenly laminated. In places they grade into coarse siltstone. The sandstone commonly contains about 15 percent calcareous cement. In some places the rock contains siliceous cement and is a quartzite. The sandstone and quartzite are composed predominantly of quartz and a few percent to over 25 percent feldspar and include types classed as quartz arenite, feldspathic arenite, and arkosic arenite. In most of the samples studied, the feldspar is entirely an albitic plagioclase, as determined by thin-section and X-ray diffraction work. Similar albitic rocks occur in the lower member of the Wood Canyon Formation, and as was suggested in the description of that unit, the abundance of albitic plagioclase in these Precambrian and Cambrian rocks is probably due to a metamorphic process rather than to a sedimentary one. Vertical worm borings (*Scolithus*) are locally abundant in the quartzite or sandstone.

The upper member of the Poleta Formation is medium-gray limestone that is indistinctly very thin to thin bedded. A few poorly preserved archeocyathids occur locally. The upper member is generally about 25–100 feet thick.

The Poleta Formation contains the most abundant Lower Cambrian trilobite fauna of any formation in the western region of the southern Great Basin. The trilobites occur in the lower half of the middle member and include *Nevadella, Laudonia, Holmia,* and two unnamed olenellids (A. R. Palmer, written commun., 1963; see also Nelson and Durham, 1966, fig. 1, pl. 3). A *Judomia*-like nevadiid has also been identified (A. R. Palmer, written commun., 1963) at two localities in this unit in Esmeralda County; however, the stratigraphic location of at least one of these may have been

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misreported, and the occurrence of this fossil in the Poleta should be confirmed by further work. Archeocyathids are abundant in the lower member, and they also occur in the lower part of the middle member and in the upper member (McKee, 1963; McKee and Gangloff, 1969). Abundant remains of an echinoderm (*Helicoplacus*) are found in the middle member at a locality in the White and Inyo Mountains (Durham and Caster, 1963).

The Poleta Formation is correlated with the carbonate-bearing unit in the upper member of the Wood Canyon Formation of the central region. This correlation is confirmed by the lithologic similarity of the Poleta to the carbonate unit in the Wood Canyon as developed at Echo Canyon, at Titanothere Canyon, and in the southern part of the Last Chance Range, Calif., and at Bare Mountain, Nev. In these areas, the lower part of the carbonate-bearing unit contains archeocyathids and is apparently continuous with the archeocyathid-bearing lower member of the Poleta. The presence of *Nevadella* in the carbonate-bearing unit of the Wood Canyon at Daylight Pass and its abundance in the Poleta also supports the correlation, as does the abundance of *Scolithus* in the upper part of the Wood Canyon and in the Poleta.

HARKLESS FORMATION

The Harkless Formation (named by Nelson, 1962, p. 142) has been given an Early Cambrian age on the basis of trilobite fossils, and it is one of the most widely exposed formations in the western region of the southern Great Basin. It is composed of siltstone, fine- to medium-grained quartzite, and in places minor amounts of limestone. The amount of quartzite in the formation decreases to the northwest, and in outcrops in the northern and northwestern parts of the region the formation consists mostly of siltstone. The largely detrital Harkless Formation is contrasted with the underlying carbonate-rich Poleta Formation. The overlying laterally variable Saline Valley Formation also contains more limestone than the Harkless and includes a distinctive type of limestone that has abundant fine to coarse rounded quartz grains. The Harkless Formation is the lateral equivalent of the uppermost part of the Wood Canyon Formation and the overlying lower and middle parts of the Zabriskie Quartzite of the central region of the southern Great Basin. The fine- to medium-grained quartzite layers in the Harkless are interpreted to be tongues of the Zabriskie.

In some areas the Harkless Formation, as mapped, includes strata that are lithologically similar to and possibly correlative with the Saline Valley Formation, a formation overlying the Harkless in the type areas of these formations in the White and Inyo Mountains. These possible Saline Valley correlatives will be discussed under the "Saline Valley Formation."

In the type area of the Harkless, which is near Andrews Mountain (loc. 1), the formation consists predominantly of greenish-gray and light-olive-gray siltstone and a few layers of yellowish-gray fine- to medium-grained quartzite. North and northwest of the type area, the quartzite tongues out into siltstone, but to the south or southeast the quartzite makes up an increasingly large proportion of the formation. The quartzite layers are lithologically identical to quartzite in the Zabriskie Quartzite of the central region and are tongues of the lower and middle parts of that formation. The facies change from quartzite on the south or southeast to siltstone on the north or northwest is also recognized elsewhere in the region (fig. 32). Most of the Harkless Formation in Esmeralda County is in the siltstone facies.

The siltstone in the Harkless Formation is grayish olive, pale olive, and dark greenish gray and is composed of silt-sized grains set in a matrix of muscovite and chlorite (table 4). The rock has been at least slightly metamorphosed everywhere and is commonly phyllite or hornfels. The hornfels is composed of muscovite, chlorite, biotite, and quartz; the chlorite and biotite commonly occur in ovoid aggregates about 0.5–1 mm across. Most of the siltstones is thinly laminated, although the stratification is commonly obscured by a secondary cleavage. Trace fossils, such as worm borings and tracks and trails of trilobites, are fairly common in the siltstone, as is *Salterella* (McKee, 1968, fig. 7), a conical fossil about one-fourth inch long.

In Esmeralda County, Nev., about the lower third of the Harkless Formation is composed predominantly of siltstone that differs from the siltstone higher in the formation by being quartzitic, coarser, and more resistant to erosion. The grain size of the detrital quartz in this rock is commonly near the boundary of coarse silt and very fine sand. In a metamorphic terrane, the rock is difficult to distinguish from the quartzite in the Andrews Mountain Member of the Campito Formation.

Limestone layers, which are from less than 1 foot to more than 100 feet thick, are interstratified with the siltstone in the lower few hundred feet of the Harkless Formation. Many of these limestone layers contain abundant remains of archeocyathids, some of which are several inches in diameter. Some of the archeocyathid-bearing limestone layers are lenticular and may be "reefs." A distinctive thin bed of purple limestone containing abundant pisolitic structures (McKee, 1968, fig. 5) occurs in the lower 100 feet of the formation in part of Esmeralda County and in the White and Inyo Mountains area.

Lenticular light-brown limestone layers, which are mostly less than a foot thick and commonly contain *Salterella,* are interstratified with siltstone in the middle and upper parts of the Harkless Formation. A regionally persistent gray or locally yellowish-brown limestone, 20–40 feet thick, occurs at the top of the formation in the White and Inyo Mountains and the Last Chance Range areas. In a few areas,

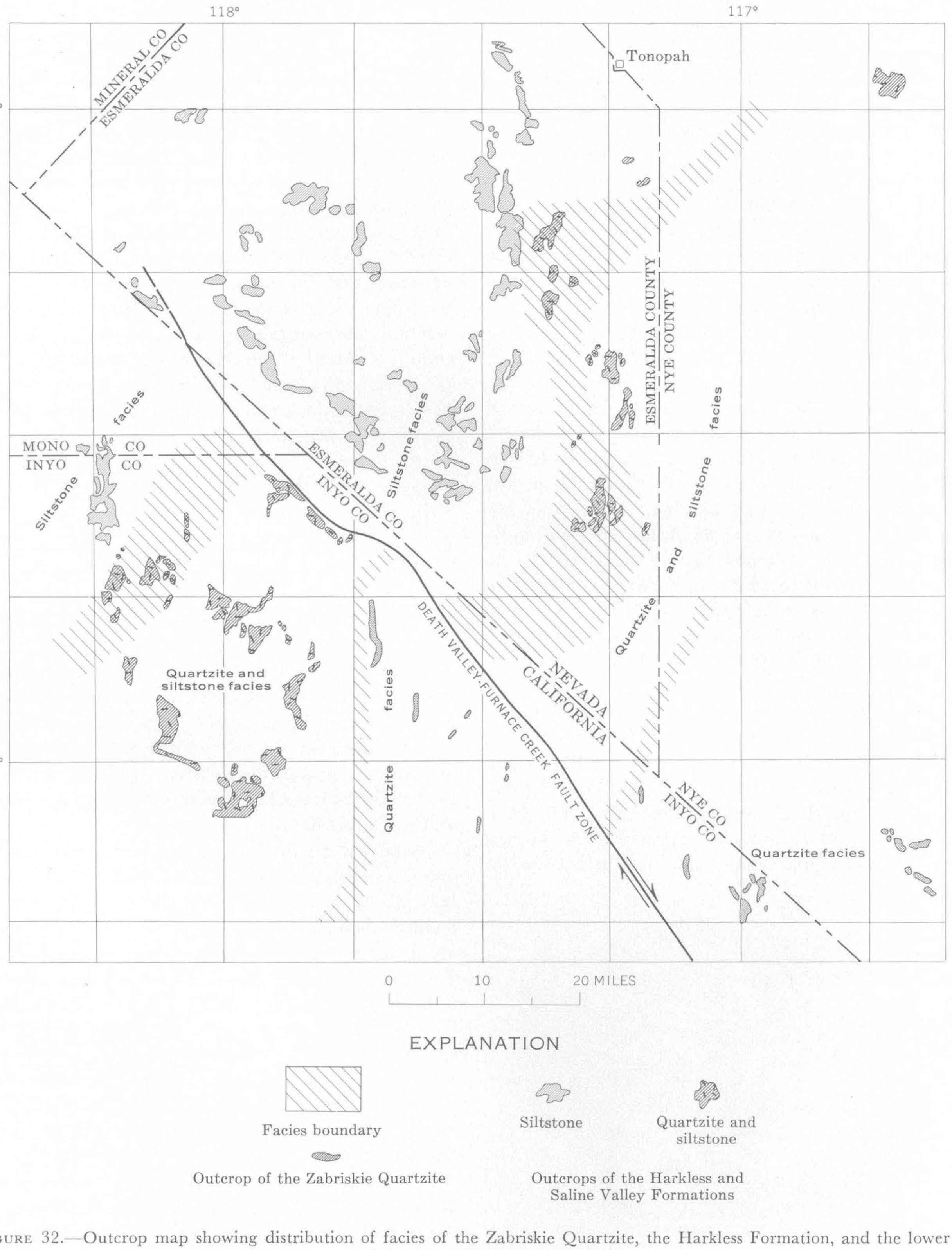


FIGURE 32.—Outcrop map showing distribution of facies of the Zabriskie Quartzite, the Harkless Formation, and the lower part of the Saline Valley Formation.

several thin layers of gray limestone occur in the first 100 feet below this persistent limestone.

The fine- to medium-grained quartzite layers (tongues of the Zabriskie Quartzite) in the Harkless Formation range in thickness from less than 1 inch to more than 300 feet and are interstratified with siltstone. The quartzite is generally yellowish gray or greenish gray and is composed of quartz grains tightly cemented into a mosaic by secondary overgrowths of quartz. Few, if any, other minerals occur in the rock, which is lithologically and mineralogically similar to the pure quartzite (97 percent SiO_2) in the Zabriskie Quartzite. The quartzite is indistinctly laminated to very thin bedded, although very small-scale cross-strata occur locally. *Scolithus* (vertical worm-tubes), horizontal worm borings (fig. 33), and trilobite sitzmarks, scratches and trails are abundant in the quartzite and are commonly preserved at the contact of the quartzite with an underlying siltstone layer (fig. 33).

The Harkness is about 2,000 feet thick in the White and Inyo Mountains (Nelson, 1962, fig. 2) and may be of comparable thickness or less in the Last Chance Range area (Stewart, 1965, fig. 14). The formation is about 3,600 feet thick at a measured section (loc. 44 in strat. sections) in Esmeralda County, Nev., although this thickness probably includes strata equivalent to the Saline Valley Formation. This stratigraphic section is the only known complete exposure of the formation in Esmeralda County, but even here some high-angle faults occur and the measurement cannot be considered exact.

Trilobites in the Harkless Formation include *Olenellus* cf. *O. gilberti* Meek, *Fremontia* cf. *F. fremonti* (Walcott), and *Paedeumias* cf. *P. clarki* Resser, which are all of Early Cambrian age (identifications and age from A. R. Palmer, written commun., 1963; see also Nelson and Durham, 1966, fig. 1, pl. 5). Trilobites also occur in the beds mapped as Harkless Formation in Esmeralda County, but these strata may be

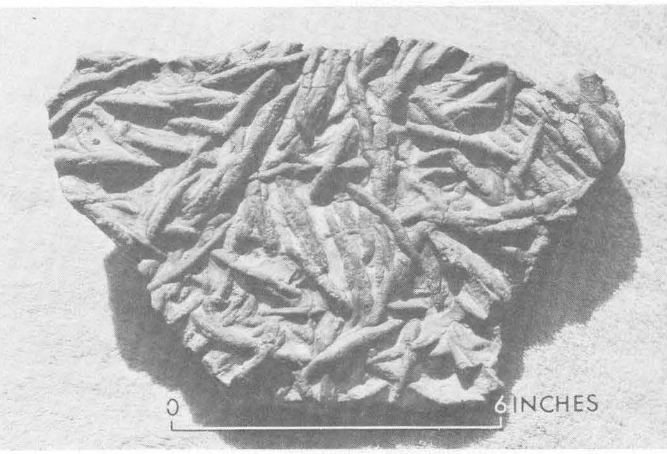


FIGURE 33.—"Worm borings" on undersurface of fine- to medium-grained quartzite layer (a tongue of the Zabriskie Quartzite) in the Harkless Formation, SW¼, sec. 4, T. 7 S., R. 38 E., Last Chance Range area, California.

equivalent to the Saline Valley Formation. Archeocyathids are abundant in the limestone in the lowermost part of the Harkless (McKee and Gangloff, 1969); *Salterella* is common in the limestone in the upper part. Brachiopods are also abundant locally in the Harkless.

The contact of the Harkless Formation and the overlying Saline Valley Formation is conformable and is placed at the top of a regionally persistent gray or locally yellowish-brown limestone. This contact marks the change from mostly siltstone and quartzite below to a horizontally and vertically variable sequence of quartzite, sandstone, limestone, sandy limestone, and siltstone above. In Esmeralda County, where the Saline Valley is not recognized, the Harkless Formation is conformably overlain by the Mule Spring Limestone. This contact is placed at the change from greenish-gray siltstone (Harkless) to gray or brown limestone (Mule Spring) containing concretionary algal structures (*"Girvanella"*) about ½–1 inch in diameter.

SALINE VALLEY FORMATION

The Saline Valley Formation (named by Nelson, 1962, p. 142), which is designated as Early Cambrian in age on the basis of trilobite fossils, is a lithologically heterogeneous and laterally variable unit recognized in the White and Inyo Mountains and Last Chance Range area of California. It contains limestone, quartzite, siltstone, and other rock types. The lithologically diverse Saline Valley is contrasted with the largely detrital sequence of the underlying Harkless Formation and the carbonate strata of the overlying Mule Spring Limestone. The Saline Valley is a lateral continuation of the upper part of the Zabriskie Quartzite and the lower part of the Carrara Formation of the central region of the southern Great Basin.

Strata that are lithologically similar to the Saline Valley are also recognized locally in Esmeralda County, although here, as was first recognized by Nelson (1962, p. 142), the Saline Valley Formation is not well defined, and strata that are in the same stratigraphic position as the Saline Valley Formation are mostly though not entirely green slitstone that is lithologically similar to the Harkless Formation. The strata that do resemble the Saline Valley Formation in Esmeralda County are spottily distributed and seemingly cannot be consistently distinguished from the Harkless Formation. For these reasons, the Harkless Formation as mapped in Esmeralda County (Albers and Stewart, 1965) includes strata that are equivalent to the Saline Valley Formation.

In the type area (loc. 2) in the southeastern part of the White and Inyo Mountains area, the Saline Valley Formation consists of a lower member (about 430 ft thick) composed of massive fine- to medium-grained quartzite, quartzitic sandstone, sandstone, and a capping limestone about 30 feet thick that contains abundant rounded fine to coarse quartz grains (Nelson, 1962, p. 142). The sandy limestone is the most distinctive rock type in the formation. The upper member is about 400 feet thick in the type area and is composed of gray limestone, greenish-gray shale, and, in the basal part, some medium-gray sandstone and quartzitic sandstone.

The Saline Valley Formation on the west side of Eureka Valley (loc. 3) and in the Last Chance Range area (loc. 5; Stewart, 1965) is generally similar to that at the type section, which is in the same area as Walcott's (1908) Waucoba Spring section in the Inyo Mountains. On Andrews Mountain (loc. 1), however, only 10 miles northwest of the type section, the Saline Valley Formation is composed predominantly of platy siltstone and fine-grained quartzitic sandstone. A 190-foot sandy limestone unit marks the top of the lower member on Andrews Mountain. The Saline Valley Formation on Andrews Mountain is finer textured than at the type section, and this change in facies continues toward the northwest.

In Esmeralda County, the strata that most closely resemble the Saline Valley Formation occur in an area about 4 miles northeast of Mount Dunfee, near Alkali Spring, and on Paymaster Ridge. These strata include pale-yellowish-brown and medium-gray limestone, sandy (fine- to coarse-grained) limestone, and pale-yellowish-brown fine- to medium-grained sandstone. The top 446 feet of the Harkless Formation in the Weepah Hills (loc. 44 in strat. sections) contains five limestone beds, 4–7 feet thick, interstratified with siltstone, but contains no sandy limestone or quartzite. This part of the Harkless Formation may be equivalent to the Saline Valley Formation, but except for the presence of the limestone is not lithologically similar to the Saline Valley Formation.

The facies in the Saline Valley Formation, at least in the lower member of the formation, follow the same trend as those in the Harkless Formation. The fine- to medium-grained quartzite layers that occur predominantly in the lower member of the Saline Valley Formation are considered, on the basis of stratigraphic position and lithologic character, to be tongues of the upper part of the Zabriskie Quartzite of the central region and are similar to the quartzite layers in the Harkless Formation that are tongues of the lower and middle parts of the Zabriskie. The quartzite layers in the Saline Valley tongue out into siltstone to the north and northwest, as do those in the Harkless. The outcrops of the Saline Valley in the southern part of the White Mountains and equivalent strata in most of Esmeralda County consist mostly of siltstone and lie north or northwest of the margin of the quartzite or sandstone layers of the formation (fig. 32).

The Saline Valley Formation and equivalent strata contain a distinctive and varied fauna of Lower Cambrian trilobites, the most abundant of which is *Ogygopsis,* a form that was until recently thought to be entirely of Middle Cambrian age (Nelson, 1962). Other trilobites in the Saline Valley Formation, some of which occur in association with *Ogygopsis,* include *Bonnia, Paedeumias,* and *Olenellus* (A. R. Palmer, 1964; written commun., 1963; Nelson and Durham, 1966, fig. 1, pl. 5). The largest single assemblage of trilobites yet described from the Lower Cambrian in North America occurs in the Saline Valley equivalent about 4 miles northeast of Mount Dunfee in Esmeralda County (Palmer, 1964). *Ogygopsis* also occurs in the Saline Valley-like strata near Alkali Spring and in siltstone that is 200–300 feet below the top of the Harkless Formation in the Weepah Hills stratigraphic section (loc. 44 in strat. sections).

The fine- to medium-grained quartzite layers in the lower member of the Saline Valley Formation are considered to be tongues of the upper part of the Zabriskie Quartzite. The upper part of the Saline Valley Formation, however, is correlated on the basis of lithologic character and stratigraphic position with the lowermost part of the Carrara Formation (pl. 2). Some of the quartzite and sandstone in the lower part of the upper member of the Saline Valley Formation may be correlative with lithologically similar strata in a widespread clastic interval in the basal 60–130 feet of the Carrara Formation.

The Saline Valley Formation, or equivalent strata, is conformably overlain by the Mule Spring Limestone, and the contact is placed at the change from siltstone below to generally massive *Girvanella*-bearing limestone above. The Mule Spring Limestone in some places contains interbedded silty limestone and limy siltstone in the lowermost part, and the contact is here placed at the base of the lowest well-defined limestone. The top 30 feet or more of the Saline Valley Formation, or equivalent strata in the Harkless Formation, commonly contains the olenellid trilobite *Paedeumias nevadensis* (Walcott) (identified by A. R. Palmer, written commun., 1963). The occurrence of this fossil, which is commonly well preserved and abundant, helps locate the contact.

MULE SPRING LIMESTONE

The Mule Spring Limestone (named by Nelson, 1962, p. 142) is the highest Lower Cambrian formation in the western region and is laterally equivalent to part of the Carrara Formation of the central region of the southern Great Basin. The Mule Spring consists of medium-gray to medium-light-gray very finely crystalline to finely crystalline locally aphanitic limestone characteristicaly containing concretionary algal structures (*Girvanella*) that are ½–1 inch in diameter (McKee, 1968, fig. 9). The limestone is very thin to thin bedded in most places, although structureless parts occur locally. Beds of pale-yellowish-brown or greenish-gray shale, limy siltstone, and silty limestone are common in the lower 100–150 feet of the formation.

The Mule Spring Limestone is about 500 feet thick in the Last Chance Range area (loc. 5; Stewart, 1965, fig. 14) and is 700–1,000 feet thick in the White and Inyo Mountains

(Scott, 1960; Nelson, 1962, fig. 2). Owing to structural complexities, the thickness in Esmeralda County is uncertain, but is apparently about 400–500 feet in most places.

Trilobites occur mostly in the lower silty part of the Mule Spring Limestone and include *Bristolia, Paedeumias, Fremontia, Bonnia,* and *Peachella* (A. R. Palmer, written commun., 1963; quoted in Stewart, 1965, p. A68).

Separate limestone units in the lower third of the Carrara Formation of the central region coalesce northwestward to form the Mule Spring Limestone. In addition to evidence from physical stratigraphy, this correlation is supported by the occurrence of *Bristolia,* a trilobite that is widely distributed in the lower part of the Carrara and the lower part of the Mule Spring.

The Mule Spring Limestone of Early Cambrian age is conformably overlain by the Monola Formation (Nelson, 1965) of Middle Cambrian age. Laterally equivalent, but lithologically somewhat different, strata of Middle and Late Cambrian age in Esmeralda County are called the Emigrant Formation (McKee and Moiola, 1962, p. 536–537; Albers and Stewart, 1962, p. D27).

SUMMARY OF REGIONAL SEDIMENTARY CHARACTERISTICS

Most of the upper Precambrian and Lower Cambrian strata in the southern Great Basin have the same general geometric, lithologic, and temporal characteristics: (1) they extend for long distances in the direction of sedimentary strike, which is to the north or northeast, without change in facies or thickness, (2) they thicken and become finer grained and more carbonate-rich in the direction of sediment transport, which is westward or northwestward, and (3) they appear to be virtually time conformable, rather than time transgressive. These characteristics indicate a uniform tectonic and sedimentary environment during much of late Precambrian and Early Cambrian time.

Strata of considerable extent in the direction of sedimentary strike (fig. 34) are best illustrated by quartzite units, particularly those in the Stirling Quartzite, Wood Canyon Formation, and Zabriskie Quartzite. The A and E members of the Stirling Quartzite (pl. 3*A*) have been recognized for a distance of 180 miles along sedimentary strike, from the Providence Mountains (loc. 41) on the south to Quartzite Mountain (loc. 54) on the north, and may originally have extended considerably farther than this. The middle member of the Wood Canyon Formation (pl. 3*B*) and the Zabriskie Quartzite (pl. 3*C*) extend for at least 240 miles, from the Marble Mountains (loc. 42) on the south to Pioche (loc. 69) on the north. These units are generally uniform in lithology throughout their extent along sedimentary strike; the most notable example is the Zabriskie Quartzite, which is everywhere a cliff-forming pinkish-gray medium- to coarse-grained vitreous quartzite. Even some thin quartzite units are widely distributed. One such unit, in the basal part of the Carrara Formation, ranges in thickness from 20 to 60 feet. It has been estimated conservatively to cover 2,000 square miles and extends about 80 miles in a north-south direction and 30–40 miles in an east-west direction.

Carbonate units are also widespread in the direction of sedimentary strike. The most notable example is the Johnnie oolite, a distinctive very pale orange oolitic dolomite in the lower part of the Rainstorm Member of the Johnnie Formation. This unit is generally 6–12 feet thick and has been recognized for a distance of 130 miles along sedimentary strike, from Old Dad Mountain (loc. 39) on the south to the Halfpint Range (loc. 56) on the north. In an east-west direction, the Johnnie oolite may extend about 50 miles, although this distance is difficult to determine precisely. Other carbonate or carbonate-bearing units that have wide distribution are (1) the carbonate unit (not the Johnnie oolite) of the Rainstorm Member, (2) carbonate-bearing strata in the lower part of the C member of the Stirling Quartzite, (3) the D member of the Stirling Quartzite, (4) three carbonate units in the lower member of the Wood Canyon Formation and correlative strata in the Deep Spring Formation, and (5) a carbonate-bearing unit in the upper part of the Wood Canyon Formation and correlative strata in the Poleta Formation.

In the direction of sediment transport, which is westward or northwestward, facies and thickness changes are conspicuous and contrast with the lithologic uniformity of the units in the direction of sedimentary strike. Quartzite units thicken and grade into siltstone, carbonate strata, or both within about a hundred miles in a westerly or northwesterly direction. The best example is the Zabriskie Quartzite (pl. 3*C*), which is only a few hundred feet thick or less in most of the eastern part of the southern Great Basin region. To the west, it thickens to over a thousand feet and grades out into an even thicker sequence of siltstone that contains some limestone. Most of the quartzite units grade westward into sequences of siltstone, but one notable exception is the E member of the Stirling Quartzite, a member composed predominantly of fine- to coarse-grained quartzite, which grades (pl. 3*A*) westward or northwestward into strata composed predominantly of massive dolomite (the Reed Dolomite).

The temporal characteristics of the upper Precambrian and Lower Cambrian strata are difficult to determine because of the lack of abundant fossils. Available fossil evidence, however, suggests that the quartzite units may be time conformable, rather than time transgressive, and this idea is perhaps supported by the regional sedimentary characteristics of these units.

The position of the Zabriskie Quartzite in relation to both overlying and underlying fossil zones suggests that the unit is time conformable. These relationships have been indicated in part by A. R. Palmer (oral commun., 1961). Two

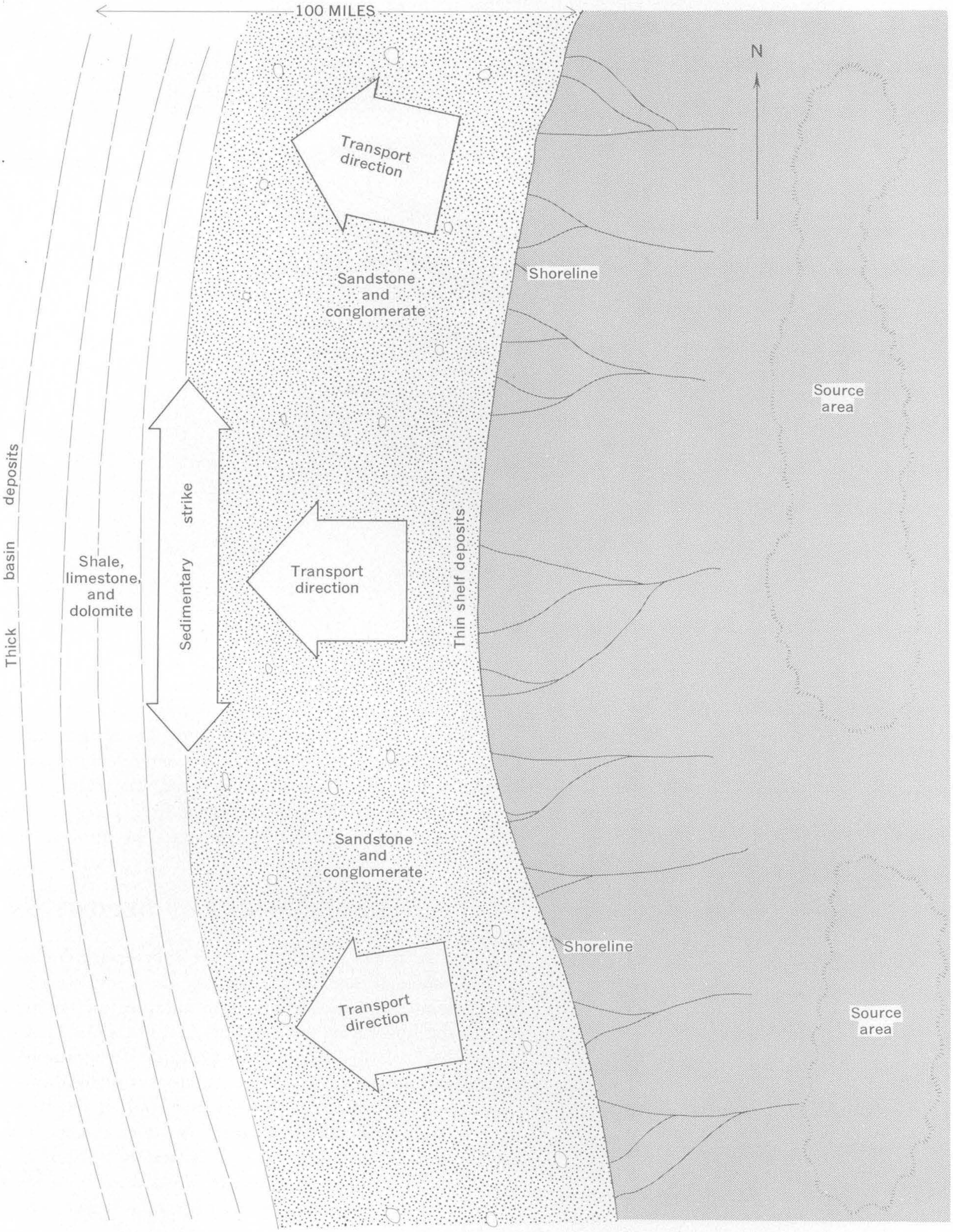


FIGURE 34.—Model of depositional framework of upper Precambrian and Lower Cambrian strata in the southern Great Basin.

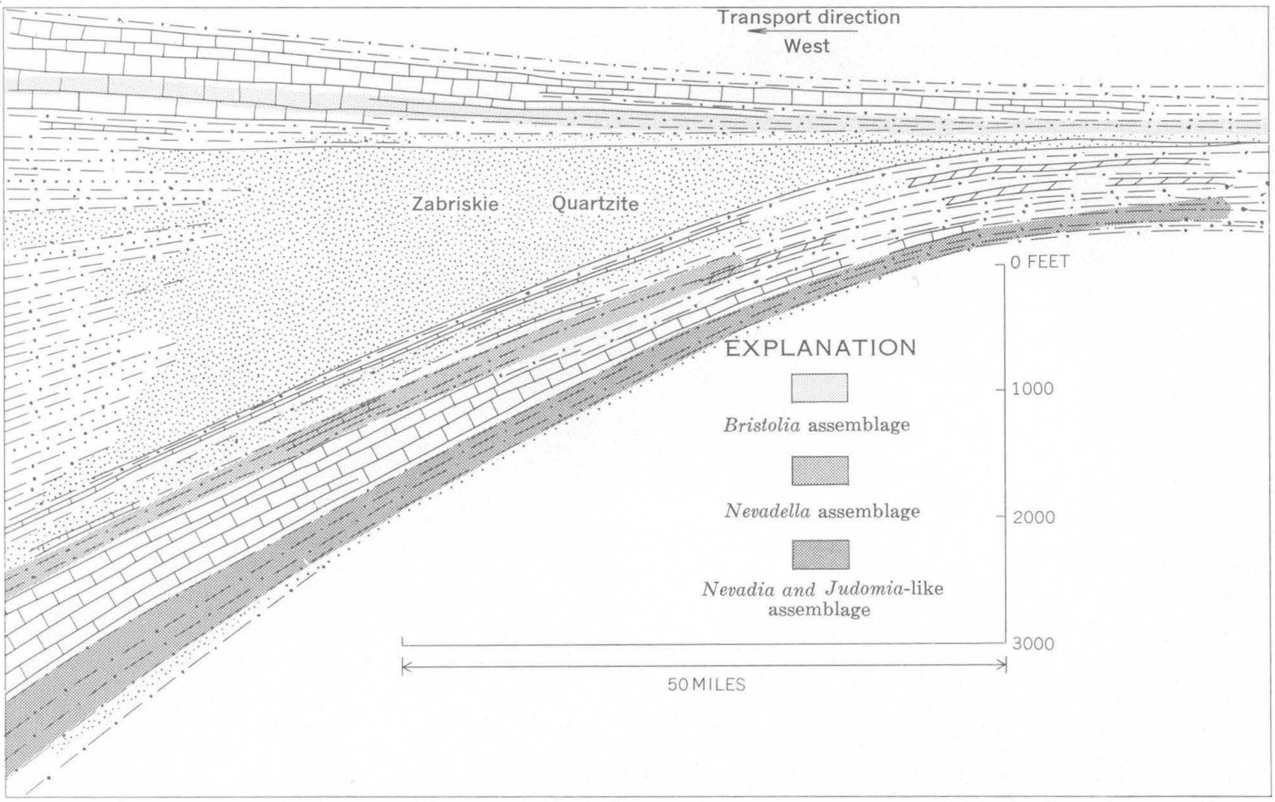


FIGURE 35.—Diagrammatic cross section showing relation of the Zabriskie Quartzite to overlying and underlying faunal zones.

zones (fig. 35) are recognized below the Zabriskie—a lower one defined by *Nevadia* and *Judomia*-like trilobites and an upper one defined by a *Nevadella* trilobite assemblage. The *Judomia*-like trilobites may extend higher in the section than shown (see discussion under "Poleta Formation"), but such a revision would not seriously affect the inferred time relationships with the Zabriskie. A well-defined zone based on the occurrence of the trilobite *Bristolia* occurs above the Zabriskie (fig. 35). The position of these faunal zones is parallel or subparallel to the boundaries of the Zabriskie Quartzite, and on the assumption that the faunal zones are time comformable, the upper and lower boundaries of the Zabriskie must be virtually time conformable as well.

The sedimentary "style" of the upper Precambrian and Lower Cambrian strata perhaps also suggests that the units are time conformable. Sedimentary units, including individual thin layers of carbonate, quartzite, and conglomerate, are persistent over large areas. Detailed sequences of lithologic types, such as distinctive alternations of limestone, siltstone, and quartzite, or of conglomerate and quartzite, also cover large areas. Units that can be best demonstrated to be time transgressive, such as the basal Cambrian sandstone units in northern and southeastern Arizona (McKee and Resser, 1945, fig. 2B; Lochman-Balk, 1956, fig. 5) and the sandstone units of Cretaceous age in New Mexico and Utah (Sears and others, 1941; Spieker, 1949), contain many individual sandstone units that cover only relatively small areas and that pinch out abruptly into siltstone and shale. In these time-transgressive units, the vertical succession of lithologic types in one area is commonly different from that in an adjacent area. Such variability contrasts with the similarity of vertical successions from place to place in the supposed time-conformable strata of the southern Great Basin.

ENVIRONMENT OF DEPOSITION

Attempts to reconstruct the sedimentary environment of almost all ancient sedimentary rocks involve much uncertainty, and such attempts to interpret the environment of the upper Precambrian and Lower Cambrian strata seem particularly difficult, in part because of the scarcity of fossils and in part because spotty outcrops, structural complexities, and metamorphic changes limit precise determination of original sedimentary features. In addition, some of the lithologic characteristics of these strata are not similar to those of recent marine sediments. Nonetheless, enough seems to be known for at least preliminary speculation.

The upper Precambrian and Lower Cambrian sequence is considered to be almost entirely, if not entirely, marine. A marine environment is suggested by the evenness of stratification and the uniformity of units along sedimentary strike.

No channels or scour surfaces more than a foot or two deep have been noted in the rocks, and the stratification is almost everywhere even and uniform (figs. 10, 16, 26). Even under close inspection the stratification is regular. In the middle member of the Wood Canyon Formation, for example, thin and persistent layers of cross-stratified sandstone are interstratified with horizontally stratified siltstone or silty sandstone layers (figs. 19–21). Such stratification might be duplicated in a single outcrop of a fluvial formation, but fluvial units are laterally variable and contain channels of sandstone and conglomerate and lenses of siltstone; the upper Precambrian and Lower Cambrian strata do not show these fluvial characteristics.

Fossils in the upper Precambrian and Lower Cambrian strata support the interpretation of a marine environment and in part indicate a shallow-water shelf environment. Most of these fossils occur in siltstone, shale, or carbonate strata in the upper part of the sequence. Trilobites, brachiopods, and echinoderms, all of which occur as well-preserved fossils and as abundant fossil debris, are marine or brackish-water forms (Moore, Lalicker, and Fischer, 1952, p. 197–198, 475 , and 578). Archeocyathids, which are locally abundant reef-forming fossils, are considered to be marine benthonic organisms that may have lived in depths ranging from 20 to 50 meters (Hill, 1964). *Scolithus,* which may be either a worm or a phoronid, is abundant in parts of the Lower Cambrian Series, and is believed to have lived in a shallow marine environment (Howell, 1943; 1962). *Hyolithes* was probably a marine sedimentary benthonic organism (Yochelson, 1961; Fisher, 1962, p. 117). Calcareous algae, although they occur in either marine or fresh-water environments, indicate shallow-water depths of not more than 30 meters in marine waters and generally less than 10 meters in fresh water (Cloud, 1942).

As indicated by the direction of dip of cross-strata, the fine- to coarse-grained late Precambrian and Early Cambrian sediments were spread by westerly currents. The currents were at right angles to isopach lines and the eastern margins of sedimentary units and thus were at right angles to presumed shorelines. This pattern suggests that the currents were of tidal origin, although no explanation can be offered for the consistent and unimodal direction of these currents, if they are indeed tidal. Tidal currents should presumably have formed eastward-dipping cross-strata during the flood tide and westward-dipping cross-strata during the ebb tide. At least locally in modern environments, however, cross-strata form largely or entirely during ebb tides, as in the Bay of Fundy (Klein, 1966), and perhaps, for some unknown reason, the cross-strata in these ancient strata also formed only during the ebb tide.

The problem of where the shoreline was during late Precambrian and Early Cambrian time and the related problem of whether most of the sediment was deposited in a nearshore environment or in an open-ocean environment have not been satisfactorily resolved. Two hypotheses seem possible to explain the observed relationships: (1) the sediments were laid down in a nearshore environment during repeated transgressions and regressions of the sea across the region, or (2) the shoreline throughout most of late Precambrian and Early Cambrian time lay far to the east of the main depositional area, and the sediments were deposited in an open-ocean environment.

The best argument in favor of a nearshore origin, as suggested in the first hypothesis, is that coarse detrital deposits in modern marine environments are near the shore and rarely do currents (other than turbidity currents) carry coarse debris more than a few miles across a shelf away from a shoreline. Coarse shelf deposits occur in some places far from shore, but they are commonly interpreted as marking the position of former shorelines during a low stand of the sea. Such evidence suggests that marine currents (other than strong tidal currents) would be an unlikely agent to spread coarse detrital material across a broad shelf. Another argument is that mud-cracked surfaces, which occur, but are rare, in the upper Precambrian and Lower Cambrian sequence, apparently indicate at least local subaerial conditions and thus possible times of regressive seas, although the mud cracks could also have formed on low islands in the sea.

On the other hand, the regional sedimentary characteristics of the upper Precambrian and Lower Cambrian strata seem to support the idea, expressed in the second hypothesis, that the shoreline lay far to the east of the main depositional area and that the sediments were deposited in an open-ocean environment. The lithologic uniformity of upper Precambrian and Lower Cambrian units over large areas seems to indicate that a uniform sedimentary environment existed over extensive areas. Such environmental uniformity might be expected in an open-ocean region, but is difficult to reconcile with a nearshore region, in which bars, inland bays, and distributary channels might be expected. The probable time-conformable characteristics of the upper Precambrian and Lower Cambrian strata are also in accord with an open-ocean environment, where currents might spread detrital material over a broad area in a relatively short time. If the deposits were laid down near shore during repeated transgressions and regressions of the sea across the region, they would be time transgressive and not time conformable.

If the coarse clastic deposits in the upper Precambrian and Lower Cambrian sequence were laid down in an open-ocean environment, a serious problem arises as to how currents, presumably tidal currents, were able to attain velocities high enough to spread sand and, at times, gravel for 100 miles or more across a broad shelf and away from a shoreline. Transport of coarse-grained material requires velocities as high as 1.2 feet per second (Nevin, 1946, pl. 1), and pebbles as large as 2 inches, a common size in the upper Precambrian and Lower Cambrian strata, require velocities as high as 5 feet per second (Fahnestock, 1963, fig. 30). Ocean currents rarely attain velocities as high as this. Tidal currents that are swift enough to transport sand occur in modern oceans only in areas where current velocities increase owing to local topographic restrictions, and in these areas the currents exceed 1 knot (1.7 feet per second) (Merifield and Lamar, 1966, 1968). The widespread distribution of cross-stratified clastic strata in the upper Precambrian and Lower Cambrian sequence means that the presumed tidal currents had a high velocity across the entire shelf, not just in restricted areas.

One possible reason for the high tidal velocities necessary to spread coarse detrital material in an open-ocean environment has been proposed by Merifield and Lamar (1966, 1968). They suggested that tidal velocities 4–14 times those of today occurred at the time of the origin of the earth-moon system and that this system may have originated in late Precambrian time. Their suggestion is based in part on astronomic and paleontological work on the length of the day and the moon-earth distance (Wells, 1963; MacDonald, 1964; Scrutton, 1964). This work suggests that the moon-earth system has been losing energy, in part owing to tidal friction, and indicates that tides in the past were higher than present-day tides.

In summary, the problem of nearshore versus open-ocean deposition of the upper Precambrian and Lower Cambrian strata has not been resolved by this study, although the widespread uniformity of the strata and their possible time-conformable relationships seem to indicate that they are open-ocean deposits. Such an explanation requires high-velocity currents, presumably tidal, in order to transport the coarse debris. The origin of these strong currents has not been explained, although the occurence of high tides and high-velocity tidal currents related to the initiation of the moon-earth system is suggested as a possible explanation.

PALEOGEOGRAPHY

The upper Precambrian and Lower Cambrian strata in the southern Great Basin are part of a westward-thickening sequence of coarse detrital and carbonate strata lying to the west of a broad cratonic area (stable interior platform) that composed most of North America during late Precambrian and Early Cambrian time (Kay, 1951, p. 7–11, 36). Coarse detrital strata, similar to those in the southern Great Basin, extend in a slightly sinuous belt from at least southern Canada to northern Mexico (fig. 36) and have been classed as miogeosynclinal (Kay, 1951, p. 7–11). A eugeosynclinal belt is presumed to have lain to the west (Kay, 1951, p. 7–11), although evidence for this belt in late Precambrian and Early Cambrian time is scarce, and none of the strata studied by the writer appear to belong to a eugeosynclinal facies.

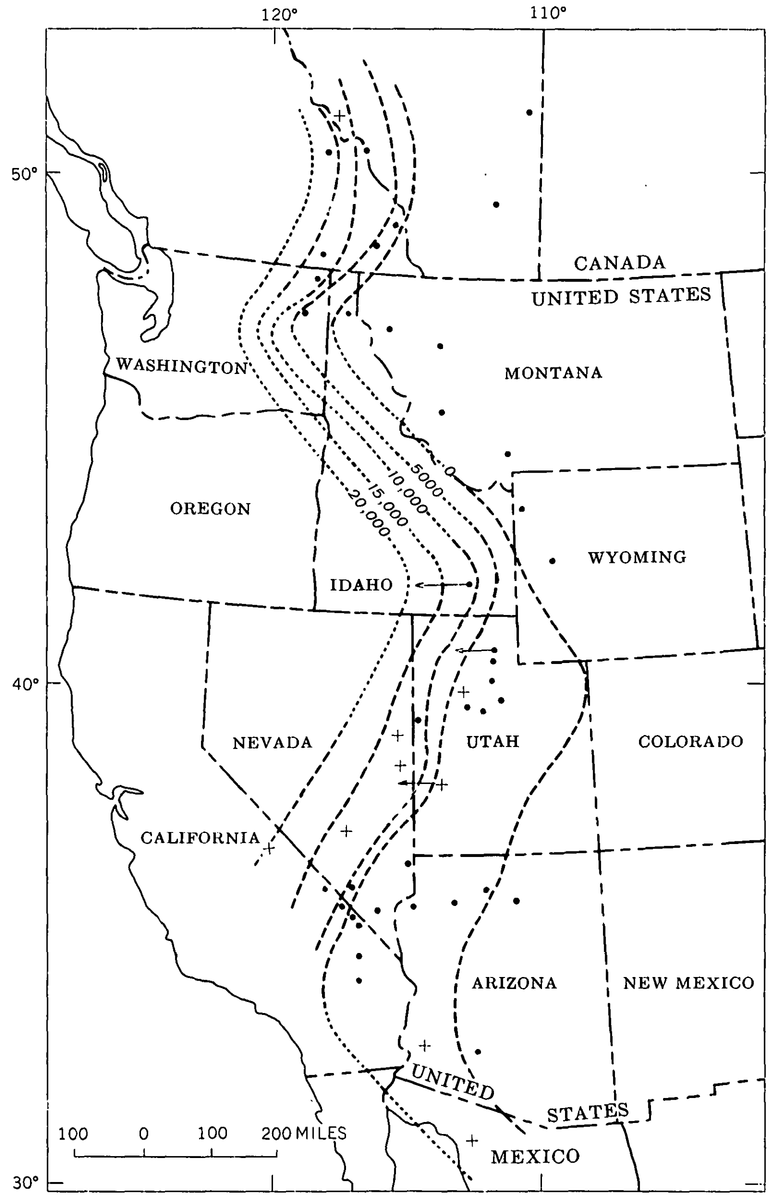
The predominant source of the coarse detrital material in the upper Precambrian and Lower Cambrian strata was the cratonic area east of the southern Great Basin. This source is clearly indicated by westerly transport directions and the lateral gradation from coarse clastic strata on the east to fine clastic strata on the west (fig. 34).

The fine detrital material in the upper Precambrian and Lower Cambrian sequence probably came from the same source as the coarse material and was deposited as the transporting power of the currents waned to the west in the more seaward parts of the geosyncline. This interpretation is suggested by the predominance of fine-textured strata in the western part of the southern Great Basin in contrast with coarse detritus in the eastern part and the known westward transport of the coarse material. The source of the fine-textured strata, however, is less clear than that of the coarse, because the direction of sediment transport of these fine-textured sediments has not been determined.

An alternate interpretation is that the fine detrital material came from the west. Some geologists (Schuchert, 1910; Deiss, 1941) have suggested that a land area ("Cascadia") with a sedimentary and crystalline terrane lay west of the Cordilleran geosyncline in early Paleozoic time and was the source of the detrital material that was deposited in the geosyncline. More recently, Kay (1951, p. 4) rejected the idea of Cascadia, but indicated the possibility that the western part of the Cordilleran geosyncline contained linear tectonic and volcanic islands that contributed debris, largely volcanic, to the geosyncline. Palmer (1960; 1966) outlined facies of Cambrian carbonate rocks in the geosyncline and also suggested (1960, p. 58) the possibility of a source to the west. He delineated generally north-south-trending inner and outer detrital belts separated by a relatively clean carbonate belt. The detrital sediments of the outer detrital belt, which is characterized by shale and silty limestone and includes the Middle and Upper Cambrian Emigrant Formation at Esmeralda County, Nev., and the White Mountains, Calif., could, as favored by Palmer (1960, p. 58), have been derived from a source to the west.

The possibility of a western source of the fine clastic material in the upper Precambrian and Lower Cambrian is difficult to support or to refute on the basis of data gathered during the present study. The lack of any coarse near-source debris in western outcrops of the upper Precambrian and Lower Cambrian strata and the lack of any definitely identifiable volcanic debris in these strata lead the writer to discount the possibility of the existence of a western source, whether volcanic, sedimentary, or crystalline.

A paleogeography that differs from the one presented above was suggested by Wright and Troxel (1966) for late Precambrian and Early Cambrian time in the Death Valley area. Their suggestion, based largely on thickness and facies



EXPLANATION

• Complete + Incomplete
Stratigraphic section

Stratigraphic section out of place owing to movement on thrust faults

Tip of arrow indicates probable original position relative to other sections. Possible disruption by strike-slip faulting not shown in southern Nevada and eastern California

Isopach

Dotted where uncertain. Contour interval 5000 feet. Thickness between top of Precambrian tillite or tilloid strata (Kingston Peak Formation in California; Mineral Fork Tillite in Utah; Shedroof Conglomerate in Washington; and Toby Formation in Canada) and base of Middle Cambrian strata. Precambrian volcanic units such as the Leola Volcanics in Washington and Irene Volcanic Formation in Canada are excluded

FIGURE 36.—Isopach map of upper Precambrian and Lower Cambrian strata in western North America.

trends, is that a north-northwest-trending marine trough was present in the area that approximately coincides with the present Amargosa Desert and southern Death Valley and that a topographic high existed southwest of the southern Death Valley area. The differences between the interpretation of Wright and Troxel and that of the writer are the result of uncertainties as to the amount, if any, of strike-slip offset on fault and shear zones in the region. Wright and Troxel (1966; 1967) suggested that the strike-slip displacement has totaled no more than a few miles on the Death Valley–Furnace Creek fault system, whereas other geologists suggest 50 miles or more of displacement (Stewart, 1967; Poole and others, 1967; Stewart and others, 1968). If 50 miles of displacement is assumed, palinsplastic isopach maps show a general west to northwest thickening and do not show a trough. As outlined elsewhere (Stewart, 1967; Stewart and others, 1968), the writer feels that the evidence is indicative of sizeable strike-slip displacements, and neither a north- to northwest-trending marine trough in the Amargosa Desert–southern Death Valley area nor a topographic high southwest of there seems to be required.

A further unresolved problem in the southern Death Valley area concerns the seemingly anomalous stratigraphic trends defined on the basis of such a feature as the margin of the lower part (algal dolomite) of the Noonday Dolomite. These trends are clearly to the northwest in the area directly east of Death Valley and are unusual because they appear to be at right angles to isopach lines and the margins of the Stirling Quartzite, Wood Canyon Formation, and Zabriskie Quartzite. As suggested elsewhere (Stewart, 1967; Stewart and others, 1968), these unusual trends might be due to a large structural bend (oroflexural fold) that has rotated strata in that area about 90° from their original position. The rotation would explain the unusual northeast (instead of northwest) resultant dip directions in the Wood Canyon Formation in the area of the presumed bend (fig. 15). Such oroflexural folds have been reported elsewhere in the region (Albers, 1967). In any case, more study is needed to understand the origin of these seemingly unusual northwest trends.

Two relatively local and short-lived uplifts, which perhaps formed islands in the sea, occurred in the Death Valley area. One, which has been described by Wright and Troxel (1967) and named "Nopah upland" by them, is thought to have supplied the coarse detrital material to parts of the Kingston Peak Formation of the Pahrump Group. The other uplift shed detrital material eastward into the depositional area of the Johnnie Formation and is indicated by granule conglomerate in the formation in the Death Valley area and by an angular unconformity at the base of the Johnnie in the Funeral Mountains. (See description under "Johnnie Formation.") The axis of this uplift may have been close to the Funeral Mountains, the area where the coarsest detrital material occurs and a pre-Johnnie unconformity is conspicuous.

PROVENANCE, MATURITY, AND MINERAL SORTING

The main source rock is clearly the older Precambrian medium- to high-grade metamorphic rocks upon which progressively younger upper Precambrian and Lower Cambrian strata rest to the east. These older Precambrian rocks are composed of metasedimentary gneiss, schist, quartzite, marble, and associated granitic and pegmatitic bodies. Grains of quartz-muscovite schist are fairly common in the lower part of the Stirling Quartzite (table 5), and the assemblage of quartz, feldspar, and micaceous minerals that constitute most of the sediments could easily have been derived from this metamorphic and igneous terrane. Granules, pebbles, and cobbles in conglomerate layers in the upper Precambrian and Lower Cambrian sequence are predominantly quartzite, quartz, and red chert (jasper). All three of these rock types occur in the older Precambrian terrane. The jasper probably was derived from older Precambrian jasper-magnetite beds and jasper veins, both of which are common in central Arizona (Anderson and Creasey, 1958, p. 19, 43–44). The jasper-magnetite beds may also have been a partial source of the metallic opaque minerals, probably at least in part magnetite, that constitute 5–10 percent of the very fine grained or fine-grained quartzite of the Andrews Mountain Member of the Campito Formation in the western region of the southern Great Basin.

The upper Precambrian and Lower Cambrian strata range from immature arkosic or feldspathic arenite (fig. 18) or wacke to mature quartz arenite containing 97 percent SiO_2 (fig. 27). As the source terrane contained a large variety of rock types, the difference in maturity is attributed to different degrees of reworking and weathering within the area of deposition. Rapid deposition without much reworking probably produced the mineralogically immature sediments, whereas reworking and weathering over a long period of time produced the highly mature sediments.

Some mineral sorting may have occurred in the upper Precambrian and Lower Cambrian strata. The best evidence of it is the variation in feldspar content in the E member of the Stirling Quartzite. The medium- to coarse-grained parts of this member contain an average of 3 percent feldspar, whereas the fine-grained facies contains an average of about 14 percent (table 5), although the amount of feldspar differs considerably from sample to sample in both facies. The fine-grained facies lies west of the medium- to coarse-grained facies and, as indicated by cross-strata studies, is downcurrent from the coarse facies. Presumably both the medium- to coarse-grained strata and the fine-grained strata were derived from the same source area—the older Precambrian rocks to the east. The differences in the feldspar content, therefore, seem to be best attributed to sedimentary processes that have concentrated the feldspar in the finer grained rocks. Feldspar tends to break more easily than quartz because of its well-developed cleavage and thus might tend to be concentrated in the finer grained sediments.

Most of the upper Precambrian and Lower Cambrian strata contain both K-feldspar and plagioclase, but a few contain only plagioclase that is predominantly albite. Such albite-rich sediments are apparently produced by metamorphism (sodium metasomatism) rather than by sedimentary processes. (See sections "Lower member of the Wood Canyon" Formation and "Poleta Formation.")

STRATIGRAPHIC SECTIONS

The thickness of stratigraphic units was mostly measured with a Jacob's staff; a few were measured with a tape. The measurements of thickness are recorded in the stratigraphic sections to the nearest foot, although the precision of these values is not known. In many places repeat measurements probably would be at least 5 percent above or below the recorded figure. A plus or minus (±) notation is used for thicknesses that seem significantly less accurate than average because of structural complexities; a query (?) is used for values that are probably even less accurate. The color names and their numerical designations have been established by comparison with the color chips on the rock-color chart distributed by the National Research Council (Goddard and others, 1948). The terminology for stratification and cross-stratification largely follows that proposed by McKee and Weir (1953).

The locations of the stratigraphic section are shown in figure 2. The data below provide a reference to the page on which each section begins.

Locality:

Locality—Continued

INYO COUNTY, CALIFORNIA

Locality 3

West side of Eureka Valley section, measured in area ½ mile east of Eureka mine, northern part of sec. 22 and southern part of sec. 15, T. 8 S., R. 37 E.

[Measured by J. H. Stewart and S. D. Stewart, November 1963]

	Feet
Top of section is a fault striking about N. 40° E. and dipping 60° SE. On west side of fault is yellowish-gray marble and minor gray hornfels. This sequence probably belongs to Monola Formation. To west of this section is thick unit of brown-weathering dolomite, probably Bonanza King Formation.	
Saline Valley Formation (incomplete):	
21. Quartzite, yellowish-gray (5*Y* 8/1); weathers same color and pale yellowish brown (10*YR* 6/2); fine to medium grained; laminated to very thin bedded in lower half; upper half mostly shallow trough sets (2–8 in. thick) of low-angle small-scale cross-strata; weathers to form cliff. Unit very thin bedded in top 35 ft. Unit quite thoroughly cracked and broken up, but appears to be intact	265
20. Marble and calc-silicate hornfels. Marble, pale-yellowish-brown (10*YR* 6/2) to very pale orange (10*YR* 8/2); weathers same colors and moderate yellowish brown (10*YR* 5/4); medium to coarsely crystalline; some relic lamination. Calc-silicate hornfels, yellowish-gray (5*Y* 8/1) to very light gray (5*Y* 8/1); weathers same colors; very fine to fine textured. Calc-silicate hornfels occurs in bottom 6 ft and top 3 ft of unit. Unit is nonresistant and forms reentrant	20

Locality 3—Continued

West side of Eureka Valley section, measured in area ½ mile east of Eureka mine, northern part of sec. 22 and southern part of sec. 15, T. 8 S., R. 37 E.—Continued

	Feet
Saline Valley Formation (incomplete)—Continued	
19. Quartzite; same as unit 15; weathers to form cliff. Layer of pale-yellowish-brown (10*YR* 6/2) and light-greenish-gray (5*GY* 8/1) very fine textured siliceous hornfels from 37 to 41 ft above base of unit	111
18. Marble and minor calc-silicate hornfels. Marble, medium-gray (*N*5); weathers same color; coarsely crystalline; some relic lamination. Calc-silicate hornfels, medium-gray (*N*5); weathers same colors and dark yellowish brown (10*YR* 4/2); very fine to fine textured; relic lamination; probably limy siltstone originally; occurs in ¼–6-inch layers interstratified with the marble. Unit is nonresistant and poorly exposed. Some of the calc-silicate hornfels contains scattered fine to medium quartz grains	24
17. Quartzite; similar to unit 15; distinct very thin beds; weathers to form cliff	24
16. Marble, medium-light-gray (*N*6) and yellowish-gray (5*Y* 8/1); weathers same colors and dark-yellowish-brown (10*YR* 6/4); finely to coarsely crystalline; laminated; forms resistant unit	8
15. Quartzite, yellowish-gray (5*Y* 8/1); weathers same color and pale yellowish brown (10*YR* 6/2); fine to medium grained; some very fine grained parts; indistinct laminae to very thin beds; some waviness to bedding locally; weathers to form cliff. Unit contains a few very thin layers of medium-light-gray (*N*6) and pale-yellowish-brown (10*YR* 6/2) calc-silicate(?) hornfels and siliceous very fine textured hornfels	110
Total of incomplete Saline Valley Formation	562
Harkless Formation:	
14. Marble, grayish-orange (10*YR* 7/4) to moderate-yellowish-brown (10*YR* 5/4) and yellowish-gray (5*Y* 8/1); weathers same colors; composed of calcite; coarsely crystalline; some relic bedding(?) (very thin beds); weathers to form a yellowish poorly resistant band on outcrop	20
13. Schist, dark-gray (*N*3); weathers dusky yellowish brown (10*YR* 2/2); medium textured; abundant biotite; weathers to form slope. No quartzite noted	96
12. Quartzite (60 percent) and schistose hornfels (40 percent); same rock types as unit 8. Quartzite occurs in layers from a few inches thick to about 20 ft thick. Unit marked by presence of prominent ledge-forming light-colored quartzite layers as much as about 20 ft thick	139
11. Quartzite and schistose hornfels; same rock types as unit 8. Quartzite constitutes about 30 percent of lower half of unit and increases upward to about 40 percent in upper half of unit. Quartzite occurs in layers 1 in. to 5 ft thick; is commonly greenish gray (5*GY* 6/1)	378

Locality 3—Continued

West side of Eureka Valley section, measured in area ½ mile east of Eureka mine, northern part of sec. 22 and southern part of sec. 15, T. 8 S., R. 37 E.—Continued

	Feet
Harkless Formation—Continued	
10. Quartzite, 10 percent schistose hornfels in top 50 ft; same rock types as unit 8. Unit weathers to form ledgy interval. Hornfels occurs in layers about 0.5–1 ft thick	98
9. Quartzite (60 percent) and schistose hornfels (40 percent); same rock types as in unit 8; occurs in interlayered sets 1 in. to 5 ft thick. Unit weathers to form slope	152
8. Quartzite and schistose hornfels. Quartzite, yellowish-gray (5*Y* 8/1) to white (*N*9), rare light-olive-gray (5*Y* 6/1); weathers same colors; grains largely obliterated by recrystallization, probably mostly fine to medium grained; some indistinct laminae to very thin beds. Schistose hornfels same as in unit 7. Sequence in unit is as follows: 0–4 ft, quartzite; 4–16 ft, schistose hornfels; 16–24 ft, quartzite; 24–29 ft, schistose hornfels; and 29–129 ft, quartzite (80 percent) and schistose hornfels (20 percent). Unit forms lowest prominent quartzite sequence. Unit weathers to form ledge	129
Offset on top of unit 7 so that overlying unit measured starting in canyon about 1,000 ft north of where underlying unit measured.	
7. Schistose hornfels and some quartzite. Schistose hornfels, olive-gray (5*Y* 4/1) and dark-greenish-gray (5*GY* 4/1); weathers same colors; abundant biotite; fine to coarse textured; some relic lamination to very thin bedding. Quartzite, yellowish-gray (5*Y* 8/1) to light-gray (*N*7); weathers same colors and dark yellowish brown (10*YR* 4/2); fine to medium grained; uncertain grain size owing to reconstitution of rock which largely destroys granular appearance of rock; occurs as ¼–3 in. layers. Quartzite occurs in top half of unit generally increasing in amount upward; probably constitutes 10 percent of upper half of unit. Prominent 3-ft layer of quartzite from 221 to 224 ft above base of unit	291
Total of Harkless Formation	1,303
Poleta Formation:	
Upper member:	
6. Marble, yellowish-gray (5*GY* 8/1) to medium-light-gray (*N*6); weathers same colors and, in some places pale yellowish brown (10*YR* 6/2); medium to very coarsely crystalline; some relic lamination to thin bedding; weathers to form light-colored cliff	75
Total of upper member	75
Middle member:	
5. Quartzite (60 percent), hornfels (30 percent), and marble (10 percent). Quartzite, yellowish-gray (5*Y* 8/1), pale-yellowish-brown (10*YR* 6/2), and medium-gray (*N*5) to light-gray (*N*7); weathers mostly pale yel-	

Locality 3—Continued

West side of Eureka Valley section, measured in area ½ mile east of Eureka mine, northern part of sec. 22 and southern part of sec. 15, T. 8 S., R. 37 E.—Continued

Poleta Formation—Continued

Middle member—Continued

	Feet
5. Quartzite (60 percent)—Continued lowish brown (10*YR* 6/2); very fine grained; evenly laminated; rare very low angle small-scale cross-laminae (cross-sections of ripple marks?); occurs in layers 1 in. to 4 ft thick. Hornfels, medium-gray (*N*5); weathers olive-gray (5*Y* 4/1); very fine textured; some mica along bedding planes; some relic bedding, mostly lamination; occurs as 1-in. to 6-ft layers; some layers contain mineral aggregates; some hornfels grade to calc-silicate hornfels and marble. Marble, yellowish-gray (5*Y* 8/1) and light-gray (*N*7); weathers same colors; finely to coarsely crystalline; occurs as 1-in. to 2-ft layers in lower 80 ft of unit. Unit weathers to form light-colored ledgy slope. A half mile north of line of section, unit contains common *Scolithus* tubes in several quartzite layers about two-thirds of way up in unit	200
Offset on top of unit 4 so that overlying units measured about 300 ft southwest of underlying units.	
4. Hornfels, quartzite, and marble. Hornfels; same as in underlying unit; rare in lower half of unit; constitutes most of upper half. Quartzite, yellowish-gray (5*Y* 8/1) to pale-yellowish-brown (10*YR* 6/2); weathers same colors; very fine grained; laminated to very thin bedded; occurs in layers 0.5–2 ft thick; constitutes about 60 percent of lower half of unit and decreases upward to only a minor amount in upper half. Marble; similar to unit 2; occurs from 35.0 to 35.5 ft and 50.5 to 52.5 ft above base of unit. Unit weathers to form slope. Unit is distinctly lighter than underlying unit, but darker than overlying unit	61
3. Hornfels, medium-gray (*N*5); weathers olive gray (5*Y* 4/1); very fine textured; abundant flakes of mica in some layers; common mineral aggregates ½–4 mm in diameter; some relic bedding and lamination. A few pale-yellowish-brown (10*YR* 6/2) and yellowish-gray (5*Y* 8/1) very fine grained quartzite layers occur in following positions: a very thin layer about 130 ft above base; a 1-ft layer from 160 to 161 ft above base; and about 20 percent of unit from 180 ft to top. A few layers of marble occur in unit in following positions: several very thin layers in basal 20 ft; a very thin layer about 130 ft above base; a layer from 165 to 167 ft above base; and a layer from 203 to 204 ft above base. Unit weathers to form slope. Thickness of unit somewhat uncertain owing to possibility of concealed faults	243
Total of middle member	504

Locality 3—Continued

West side of Eureka Valley section, measured in area ½ mile east of Eureka mine, northern part of sec. 22 and southern part of sec. 15, T. 8 S., R. 37 E.—Continued

Poleta Formation—Continued

Lower member:	Feet
2. Marble, very pale orange (10*YR* 8/2); weathers same color; finely to medium crystalline; very thin bedded; weathers to form prominent light-colored cliff. Some brecciation in hornfels directly below marble indicating some movement along lower surface of unit; movement on this surface could make thickness inaccurate. Unit appears somewhat thicker (175± ft ?) on outcrops ½ mile south. Two or three very thin layers of gray hornfels in top third of unit	133
Total of lower member	133
Total of Poleta Formation	712

Campito Formation:

1. Hornfels (80 percent) and quartzite (20 percent). Hornfels, medium-dark-gray (*N*4); weathers same colors; very fine textured; commonly contains mineral aggregates(?) (pseudoporphyroblasts?) that show as spots 1–6 mm in diameter; some relic bedding and laminated. Quartzite, very pale orange (10*YR* 8/2) and light-gray (*N*7), very fine grained, laminated; occurs as 0.5–1-ft layers interstratified with hornfels. Unit weather to form slope	Unmeasured

Base of section; not base of outcrop.

Locality 4

Northern part of Last Chance Range No. 2 section, measured about 1½ miles northwest of Cucomungo Canyon, east-central part of sec. 15, T. 7 S., R. 38 E.

[Measured by J. H. Stewart and S. D. Stewart, April 1963]

Top of section; top of continuous unfaulted section.

Harkless Formation (incomplete):	Feet
13. Siltstone (90 percent) and quartzite (10 percent). Siltstone, dark-greenish-gray (5*GY* 4/1), grayish-olive (10*Y* 4/2), and rare medium-gray (*N*5); weathers same colors; fine to medium silt; micaceous; evenly and wavy laminated; platy splitting; many trilobite trails and worm trails and burrows along bedding planes. Quartzite, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1); weathers same colors; very fine grained; laminated to very thin bedded; occurs as ½–6-in. layers interstratified with siltstone. In addition to the above quartzite, other thicker and coarser quartzite layers occur. This quartzite is grayish purple (5*P* 4/2) to medium gray (*N*5), pinkish-gray (5*YR* 8/1), and yellowish gray (5*Y* 8/1) (weathers same colors), is fine to coarse grained, is fairly well sorted, and is in layers 6 in. to 9 ft thick interstratified with rest of unit. This latter quartzite occurs as five beds 6 in. to 3 ft thick from 197 to	

Locality 4—Continued

Northern part of Last Chance Range No. 2 section, measured about 1½ miles northwest of Cucomungo Canyon, east-central part of sec. 15, T. 7 S., R. 38 E.—Continued

Harkless Formation (incomplete)—Continued *Feet*

13. Siltstone (90 percent)—Continued
249 ft above base of unit, as a bed from 381 to 389 ft, as a bed from 395 to 398 ft, and as a few 1–2-ft beds in top 125 ft of unit. Thickness and stratigraphic succession in top 125 ft of unit uncertain owing to probable faults and minor contortions. Trilobites that probably can be designated *Fremontia*(?) and *Paedeumias*(?) (identified by C. A. Nelson, written commun., 1964) occur in a 20±-ft zone approximately 280 ft above base of unit ---------- 580±

Total of incomplete Harkless Formation ------ 580±

Poleta Formation:

Upper member:

12. Limestone; medium light gray (*N*6) to medium gray (*N*5) from 0 to 21 ft; light gray (*N*7) from 21 to 51 ft; medium gray (*N*5) from 51 to 63 ft; dark yellowish brown (10*YR* 4/2) from 63 to 73 ft; weathers same colors; some mottling of pale yellowish brown (10*YR* 6/2) from 51 to 63 ft; very finely to finely crystalline; some oolites (no internal structure seen) in basal 10 ft of unit; indistinct very thin to thin beds; weathers to form prominent ridge and locally forms crest of range ---------- 73

Total of upper member ---------- 73

Middle member:

11. Siltstone to quartzitic siltstone (80 percent) and quartzite (20 percent). Siltstone to quartzitic siltstone, medium-gray (*N*5) to olive-gray (5*Y* 4/1); weather same colors; some fine-grained siltstone, but mostly coarse-grained siltstone grading into very fine grained sandstone; commonly quartzitic; evenly and thinly laminated in places. Quartzite, pale-yellowish-brown (10*YR* 6/2) to yellowish-gray (5*Y* 8/1); weathers same colors; very fine grained; evenly laminated in places; occurs as 0.5–10(?)-ft layers interstratified with siltstone. Unit as a whole poorly exposed and weathers to form steep rubble-covered slope. An olive-gray (5*Y* 4/1) dark-yellowish-brown (10*YR* 4/2)-weathering finely crystalline limestone bed 1 ft thick occurs about 25 ft below top of unit. *Scolithus* tubes noted in float in this unit 500 ft to southeast. Some worm burrows noted along bedding planes in siltstone ----- 86

10. Limy sandstone to sandy limestone, very pale orange (10*YR* 8/2) to pale-yellowish-brown (10*YR* 6/2); weather same colors and grayish orange (10*YR* 7/4); all gradations from limy very fine grained sandstone to very fine grained sandy limestone (some limestone contains only a small amount of sand); sandstone and limestone are evenly laminated to very thin bedded; weather to form minor ledge.

Locality 4—Continued

Northern part of Last Chance Range No. 2 section, measured about 1½ miles northwest of Cucomungo Canyon, east-central part of sec. 15, T. 7 S., R. 38 E.—Continued

Poleta Formation—Continued

Middle member—Continued *Feet*

10. Limy sandstone to sandy limestone—Continued
Unit somewhat faulted and thickness of unit could be somewhat in error ---------- 33

9. Quartzite and siltstone. Quartzite, pale-yellowish-brown (10*YR* 6/2); weathers same color; very fine grained; evenly laminated to thin bedded. Siltstone, dark-greenish-gray (5*GY* 4/1) to medium-dark-gray (*N*4), and minor light-olive-gray (5*Y* 5/2); weathers same colors; some fine to medium silt and some coarse silt grading to very fine sand; quartzitic in places; platy splitting in part; occurs as three layers—one from 28 to 34 ft, one from 48 to 52 ft, and one from 58 to 63 ft above base of unit. Unit as a whole weathers to form steep slope. Quartzite is limy in a few places. Unit grades into overlying unit ------ 76

8. Limestone, siltstone, and quartzite. Limestone, light-olive-gray (5*G* 6/1) and grayish-orange (10*YR* 7/4) with irregular patches and mottles of medium gray (*N*5); weathers dominantly grayish orange (10*YR* 7/4) with minor medium-light-gray (*N*6) mottles; very finely crystalline, almost aphanitic; wavy beds ½–3 in. thick. Siltstone, dark-greenish-gray (5*GY* 4/1), olive-gray (5*Y* 4/1), and light-olive-gray (5*Y* 5/2); weathers same colors; fine silt; platy splitting. Quartzite; same as that in underlying unit. Sequence is as follows: 0–3 ft, limestone; 3–24 ft, siltstone with one 5-in. quartzite bed and one 4-in. limestone bed in top 10 ft; 24–29 ft, limestone; 29–56 ft, siltstone with 90 percent quartzite in top 7 ft; and 56–64 ft, limestone. Unit as a whole weathers to form slope with ledges on limestone units. Limestone contains a few conical objects about ½ in. long, which may be *Hyolithes* ---------- 64

7. Siltstone (60 percent) and quartzite (40 percent). Siltstone, dark-greenish-gray (5*GY* 4/1); weathers same color; fine silt; some mica; evenly laminated; platy splitting. Quartzite, pale-yellowish-brown (10*YR* 6/2) and minor greenish-gray (5*GY* 6/1); weathers same color; very fine grained; evenly laminated; occurs in 1-in. to 3-ft layers interstratified with siltstone. Quartzite increases in proportion to siltstone upward in unit from about 20 percent near base to 80 percent near top. Unit contains a few (1 percent) 1–3-in. layers of moderate-yellowish-brown (10*YR* 5/4) limestone. Unit as a whole weathers to form slope ---------- 81

6. Limestone and siltstone. Limestone, pale-yellowish-brown (10*YR* 6/2), with medium-gray (*N*5) mottles in basal 4-ft limestone unit; weathers grayish orange (10*YR* 7/4); very

Locality 4—Continued

Northern part of Last Chance Range No. 2 section, measured about 1½ miles northwest of Cucomungo Canyon, east-central part of sec. 15, T. 7 S., R. 38 E.—Continued

Poleta Formation—Continued
Middle member—Continued

	Feet
6. Limestone and siltstone—Continued finely crystalline; almost aphanitic; evenly laminated to very thin bedded. Siltstone; same as that in underlying unit. Sequence in unit is as follows: 0–4 ft, mottled limestone; 4–11 ft, siltstone; 11–14 ft, limestone with some limy siltstone. Unit forms small ledge. Unit recognizable by threefold division of light limestone, dark siltstone, and light limestone	14
5. Siltstone and sparse limestone and quartzite. Siltstone, olive-gray (5*Y* 4/1), dark-greenish-gray (5*GY* 4/1), medium-dark-gray (*N*4), and grayish-olive (10*Y* 4/2); weathers same colors; fine to medium silt; some mica; evenly laminated; platy splitting; common trilobite tracks. The trilobite *Nevadella* (identified by A. R. Palmer, written commun., 1963) occurs in middle one-third of unit. A few (2 percent) 4–8-in. layers of pale-yellowish-brown (10*YR* 6/2) to dark-yellowish-brown (10*YR* 4/2) limestone occur in unit. One such bed about 10 ft above base contains well-preserved archeocyathids. Quartzite occurs in about six 0.5–2-ft-thick layers in top 41 ft of unit; is pale yellowish brown (10*YR* 6/2), very fine grained, and evenly laminated. Unit as a whole weathers to form slope	181
4. Limestone; similar to unit 2; weathers to form ledge	7
3. Limestone (50 percent) and siltstone (50 percent). Limestone, very pale orange (10*YR* 8/2); weathers same color; finely to medium crystalline; distinct bed ½–3 in. thick. Siltstone, grayish-olive (10*Y* 4/2); weathers same color; fine to medium silt; micaceous; platy splitting. Limestone occurs mostly in top and bottom third of unit and siltstone mostly in middle third. Unit as a whole weathers to form slope at top of cliff formed on underlying unit. Unit distinctly bedded in comparison with underlying unit	47
Total of middle member	589

Lower member:

	Feet
2. Limestone, very pale orange (10*YR* 8/2) and yellowish-gray (5*Y* 8/1); weathers dominantly very pale orange (10*YR* 8/2); medium crystalline; stratification indistinct; some parts are very thin bedded. Unit weathers to form cliff. Unit locally contains abundant pelmatozoa plates and also a few indistinct but possible archeocyathids about ¼ in. in diameter; unit appears recrystallized and original bedding and possibly archeocyathids may have been largely destroyed. A 6-in. layer of oolitic limestone occurs about 3 ft above base of unit; oolitic structure could also be destroyed in much of unit	189
Total of lower member	189
Total of Poleta Formation	851

Campito Formation:

	Feet
1. Quartzitic siltstone and quartzite, dark-greenish-gray (5*GY* 4/1) and greenish-black (5*GY* 2/1), minor pale-yellowish-brown (10*YR* 6/2); weather same colors and olive gray (5*Y* 4/1); coarse silt to very fine grained sand; coarser parts are generally pale yellowish brown (10 *YR* 6/2); stratification rarely seen, but some rocks are evenly laminated. Unit weathers to form canyons and ridges. Strata are highly fractured. No definitely determinable Montenegro Member present; this member may not be apparent owing to crushing and alteration of rock or may be absent owing to a fault at base of Poleta Formation. (Such a fault cannot be demonstrated, but its occurrence is not unlikely.)	Unmeasured

Base of section; considerable thickness of Campito Formation exposed to northeast, but strata are structurally contorted and not suitable for measurement of thickness.

Locality 5

Northern part of Last Chance Range No. 3 section, measured on northwest side of Cucomungo Canyon parallel to road, southeastern part of sec. 14 and northeastern part of sec. 23, T. 7 S., R. 38 E.

[Measured by J. H. Stewart, April 1963]

Top of section at probable fault, brings small outcrop of greenish-gray siltstone, containing one 3-ft moderate-yellowish-brown limestone bed, in contact with unit 17. This siltstone unit could be strata originally overlying unit 17, but now faulted and contorted.

Mule Spring Limestone:

	Feet
17. Limestone, medium-gray (*N*5); weathers same color; very finely crystalline; indistinct beds ½ in. to 1 ft. thick; weathers to form prominent ridge. *Girvanella* occur rarely at several positions within the unit. Thickness approximate; probably some minor faults	300±
16. Limestone, medium-gray (*N*5) and rare olive-green (5*Y*4/1); weathers same colors and abundant light brown (5*YR* 6/4); occurs as irregular layers ⅛–1 in. thick; very finely crystalline; beds ¼–2 in. thick; weathers to form steep slope, forming reentrant between overlying and	

Locality 5—Continued

Northern part of Last Chance Range No. 3 section, measured on northwest side of Cucomungo Canyon parallel to road, southeastern part of sec. 14 and northeastern part of sec. 23, T. 7 S., R. 83 E.—Continued

	Feet
Mule Spring Limestone—Continued	
16. Limestone, medium-gray—Continued underlying medium-gray limestone units. *Girvanella* occur locally; trilobite scraps abundant in places. The trilobites *Bonnia* sp., *Peachella iddingsi* (Walcott), *Paedeumias* sp., and *Bristolia* n. sp. collected (USGS colln. 4161–CO) and identified by A. R. Palmer (written comun., 1963) from upper part of unit	94
15. Limestone, medium-gray (*N*5), rare light-brown (5*YR*6/4); weathers same colors (light brown is more abundant on weathered surfaces than on fresh rock; it occurs as mottles and as coloration of irregular layers); very finely crystalline; indistinct wavy beds ½–2 in. thick; weathers to form cliff. Lower 58 ft of unit contains more abundant light-brown-weathering limestone than rest of unit. Top 58 ft of unit is dominantly medium gray weathering and forms a more prominent cliff than lower half of unit. *Girvanella* occur as scattered individuals throughout much of unit and are abundant in basal 30 ft and from 58 to 68 ft above base of unit	116±
Total of Mule Springs Limestone	510±
Saline Valley Formation:	
14. Siltstone, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1); weathers same colors; fine to medium silt; platy splitting. Weathers to form steep slope	48
13. Quartzite, pale-yellowish-brown (10*YR* 6/2); weathers same color; very fine grained; some indistinct thin beds; highly fractured; weathers to form minor ledge	7
12. Limestone to silty limestone (80 percent) and siltstone (20 percent). Limestone to silty limestone, medium-gray (*N*5), olive-gray (5*Y* 4/1), and grayish-orange (10*YR* 7/4); weather same colors except that grayish orange (10*YR* 7/4) is most prominent weathering color; very finely crystalline; fine to medium silt; evenly laminated to beds 1–2 in. thick. Siltstone, dark-greenish-gray (5*GY* 4/1) and medium-gray (*N*5); weathers same colors; fine to medium silt; micaceous; platy splitting; occurs as layers 2–5 ft thick interstratified with limestone to silty limestone. Basal 5 ft of unit is siltstone. Unit as a whole weathers to form steep slope	77±
11. Limestone, medium-gray (*N*5) and yellowish-gray (5*Y* 8/1); weathers same colors and grayish orange (10*YR* 7/4); finely to medium crystalline; laminated to very thin bedded; weathers to form ledge	40±
10. Siltstone, dark-greenish-gray (5*GY* 4/1) to greenish-gray (5*GY* 6/1); weathers same colors; fine to medium silt; micaceous; platy cleavage. Unit	

Locality 5—Continued

Northern part of Last Chance Range No. 3 section, measured on northwest side of Cucomungo Canyon parallel to road, southeastern part of sec. 14 and northeastern part of sec. 23, T. 7 S., R. 83 E.—Continued

	Feet
Saline Valley Formation—Continued	
10. Siltstone, dark-greenish-gray—Continued contains several light-brown (5*YR* 6/4) very fine grained laminated sandstone layers 4–6 in. thick in top 10± ft of unit. Unit is in structurally complex area and thickness is uncertain	34±
9. Limestone to silty limestone and sandy limestone. Limestone, medium-gray (*N*5) and olive-gray (5*Y* 4/1); weathers same colors. Silty limestone, light-brown (5*YR* 6/4), pale-yellowish-brown (5*YR* 6/2), and moderate-yellowish-brown (10*YR* 5/4); weathers same colors. Limestone to silty limestone (all gradations, locally grades to limy siltstone); medium silt; very finely crystalline; even beds ¼–1 in. thick. Sandy limestone, medium-gray (*N*5) to light-gray (*N*7); weathers same colors and moderate yellowish brown (10*YR* 5/4); composed of rounded medium to very coarse quartz grains (20–50 percent) set in lime matrix (50–80 percent); very thin to thin bedded; occurs as 1-in. to 2-ft layers interstratified with limestone and silty limestone. Sandy limestone constitutes 50 percent of lower 15 ft of unit and is rare (< 2 percent) in rest of unit. Lower part of unit contains *Wanneria* sp., *Paedeumias*? sp., and *Salterella* which were collected (USGS colln. 4162–CO) and identified by A. R. Palmer (written commun., 1963)	65
8. Quartzite, pinkish-gray (5*YR* 8/1), grayish-red-purple (5*RP* 4/2), and minor grayish-purple (5*P* 4/2) and yellowish-gray (5*Y* 8/1); weathers same colors; more pink weathering than in unit 5; medium-grained; some coarse grains; fairly well sorted; laminated to very thin bedded; weathers to form cliffs. Basal 40 ft is a dark color but contains some grayish red (5*R* 4/2)	478
Total of Saline Valley Formation	749±
Harkless Formation (incomplete):	
7. Limestone in lower 6 ft and dolomite in rest of unit, medium-gray (*N*5), olive-gray (5*Y* 4/1), and dark-yellowish-brown (10*YR* 4/2); weather moderate yellowish brown (10*YR* 5/4); very finely crystalline; indistinct beds 6–12 in. thick; weather to prominent brown ledge. Contain common conical fossils (*Salterella*) about 2 mm in diameter and 5–8 mm long	19
6. Siltstone and quartzite. Siltstone, dark-greenish-gray (5*GY* 4/1) to greenish-gray (5*GY* 6/1); weathers same colors; fine to medium silt; platy cleavage. Quartzite, dark-greenish-gray (5 *GY* 4/1) and pale-yellowish-brown (10*YR* 6/2); weathers same colors; medium to coarse grained; occurs as layers from 2 to 3 ft and from 20 to	

Locality 5—Continued

Northern part of Last Chance Range No. 3 section, measured on northwest side of Cucomungo Canyon parallel to road, southeastern part of sec. 14 and northeastern part of sec. 23, T. 7 S., R. 83 E.—Continued

	Feet
Harkless Formation (incomplete)—Continued	
6. Siltstone and quartzite—Continued 23 ft above base of unit; some internal lamination in quartzite. Unit as a whole weathers to form greenish reentrant. Unit from 4 to 6 ft above base contains mostly dark-yellowish-brown (10*YR* 4/2) silty very fine grained sandstone	28
5. Quartzite, grayish-purple (5*P* 4/2) to medium-gray (*N*5); minor very light gray (*N*8) color bands (1–4 ft thick) from 130 to 310 ft above base of unit; weathers same colors; medium to coarse grained; fairly well sorted; slightly wavy laminae; some parts very thin to thin bedded; weathers to form cliffs. Unit in about top 40 ft is dominantly yellowish gray (5*Y* 8/1) to very light gray (*N*8) with minor 1–2-ft layers that are dark greenish gray (5*GY* 4/1)	318
4. Quartzite (94 percent) and siltstone (6 percent). Quartzite, grayish-purple (5*P* 4/2) to grayish-red-purple (5*RP* 4/2), dark greenish-gray (5*GY* 4/1) to greenish-gray (5*GY* 6/1), and yellowish-gray (5*Y* 8/1); weathers same colors; fine to medium grained; some scattered coarse grains; fairly well to poorly sorted; indistinctly irregularly laminated to very thin bedded; rare 3–6-in. tabular planar sets of low-angle small-scale cross-strata. Siltstone, greenish-gray (5*GY* 6/1) to medium-light-gray (*N*7); weathers same colors; fine to medium silt; micaceous; platy splitting. Unit as a whole weathers to form ledgy steep slope. Unit is banded with beds of purple quartzite and green quartzite and siltstone. Detailed stratigraphy is as follows: 0–52 ft, purple and yellowish-gray quartzite; 52–79 ft, greenish-gray and purple quartzite with 20 percent siltstone; 79–94 ft, purple quartzite; 94–106 ft, yellowish-gray quartzite with 10 percent siltstone; 106–137 ft, purple quartzite; 137–160 ft, greenish-gray, with minor yellowish-gray, quartzite with one 0.5-ft siltstone layer near middle of interval and some purple quartzite near top; 160–172 ft, purple quartzite; 172–178 ft, greenish-gray quartzite; 178–185 ft, purple quartzite; 185–220 ft, greenish-gray quartzite with 20 percent siltstone	220
3. Quartzite (80 percent) and siltstone (20 percent). Quartzite, dark-greenish-gray (5*GY* 4/1) and minor pale-olive (10*Y* 6/2), pale-purple (5*P* 6/2) grayish-red (5*R* 6/2); weathers same colors; fine to medium grained; some scattered coarse grains; fairly well to poorly sorted; occurs in indistinct layers 1 in. to several feet thick	

Locality 5—Continued

Northern part of Last Chance Range No. 3 section, measured on northwest side of Cucomungo Canyon parallel to road, southeastern part of sec. 14 and northeastern part of sec. 23, T. 7 S., R. 83 E.—Continued

	Feet
Harkless Formation (incomplete)—Continued	
3. Quartzite (80 percent)—Continued interstratified with siltstone; layers commonly are laminated; some contain 2–5-in.-thick tabular planar sets of small-scale low-angle cross-strata. Siltstone (phyllitic), greenish-gray (5*GY* 6/1) and minor medium-gray (*N*5); weathers same colors; fine to medium silt; micaceous; platy cleavage. Unit as a whole weathers to form steep cliffy slope. Thickness of unit more uncertain than some of others owing to numerous faults	210±
2. Quartzite and siltstone. Quartzite, yellowish-gray (5*Y* 8/1), light-gray (*N*7), pale-red (10*R* 6/2), light-greenish-gray (5*GY* 8/1), greenish-gray (5*GY* 6/1), and grayish-purple (5*P* 4/2); weathers moderate yellow (5*Y* 7/6), moderate red (5*R* 5/4), light greenish gray (5*GY* 8/1), and yellowish gray (5*Y* 8/1); colors banded, bands generally 1–4 ft thick; fine to medium grained; some scattered coarse grains; indistinct irregular laminae to beds 1 ft thick. Siltstone; same as that in underlying unit; occurs in ¼–8-in. layers interstratified with quartzite from 138 to 172 ft above base of unit. Siltstone constitutes about 20 percent of strata from 138 to 172 ft but is absent from rest of unit. Unit as a whole weathers to form cliff with bright color bands of yellow, red, green, and gray. *Scolithus* tubes, worm trails, and trilobite trails common in interval from 138 to 172 ft	224
1. Quartzite (90 percent) and siltstone (10 percent). Quartzite, grayish-purple (5*P* 4/2), dark-greenish-gray (5*G* 4/1), greenish-gray (5*GY* 6/1), and yellowish-gray (5*Y* 8/1); weathers same colors; fine to medium grained; rare coarse-grained parts, some coarse grains locally in fine- to medium-grained quartzite; mostly laminated to very thin bedded (irregular laminae to beds 1 ft thick). Siltstone (phyllitic), greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 8/1); weathers same colors; fine to medium silt; micaceous; platy cleavage; occurs in ¼-in. to 1-ft layers interstratified with quartzite, mostly in layers ¼–2 in. thick. Unit as a whole weathers to form cliff. Many small faults of 5–10-ft stratigraphic displacement. Quartzite highly fractured and very crumbly	280±
Total of incomplete Harkless Formation	1,299±

Base of section; base of exposure. Base of section at wash.

Locality 6

Northern part of Last Chance Range No. 1 section, measured about 1–3 miles southeast of Cucomungo Canyon, sec. 31 and 32 (unsurveyed), T. 7 S., R. 39 E., and sec. 24, T. 7 S., R. 38 E.

[Measured by J. H. Stewart, April and May 1963]

Campito Formation:

Andrews Mountain Member: *Feet*

30. Siltstone, olive-gray (5*Y* 4/1) to medium-dark-gray (*N*4); weathers same colors, with moderate yellowish brown (10*YR* 5/4) along fracture surfaces; coarse silt; grades to very fine grained sandstone in places; laminated to thin bedded; weathers to form steep rubble-covered slope. Basal 15± ft of unit contains several 6-in. to 2-ft layers of very pale orange (10*YR* 8/2) to pale-yellowish-brown (10*YR* 6/2) finely crystalline limestone and most of the siltstone is moderate yellowish brown (10*YR* 5/4) and light olive gray (5*Y* 5/2) Unmeasured

Deep Spring Formation and upper part of Reed (?) Dolomite:

Upper member:

29. Limestone, very pale orange (10*YR* 8/2); weathers same color and grayish orange (10*YR* 7/4); finely crystalline; laminated to thin bedded; weathers to form ledge. Unit contains a few ¼–1-in. layers of moderate-yellowish-brown (10*YR* 5/4) medium- to coarse-grained siltstone in lower half. Unit forms brownish well-bedded cap to carbonate unit at top of upper member of Deep Spring Formation ---------------------------- 26±
28. Dolomite, yellowish-gray (5*Y* 8/1) to light-gray (*N*7); some very pale orange (10*YR* 8/2) in top 5 ft; weathers same colors with grayish orange (10*YR* 7/4) common in top 5 ft; very finely to finely crystalline; thin bedded; weathers to form cliff. Unit is highly faulted; faults have displacements of 20–30 ft. Thickness of unit could be in error by about 10 ft. Unit contains some dolomitic limestone------ 35±
27. Siltstone (50 percent) and quartzite (50 percent). Siltstone, dark-greenish-gray (5*GY* 4/1), olive-gray (5*Y* 4/1), and medium-gray (*N*5); weathers same colors; medium silt; some coarse siltstone in places; abundant flakes of mica; slightly wavy laminae to thin beds. Quartzite, very pale orange (10*YR* 8/2) to pale-yellowish-brown (10*YR* 6/2), dark-greenish-gray (5*GY* 4/1), and medium-gray (*N*5); weathers same colors; very fine to fine grained; grades into coarse silt; evenly and thinly laminated; some waviness to stratification; perhaps some ripple-laminated parts; occurs as layers 1 in. to many feet thick interstratified with siltstone. Amount of quartzite increases upwards. Quartzite probably constitutes only 20 percent of strata in lower 40 ft, but 80 percent in top 50 ft. Many gradational types between siltstone and quartzite. A few worm burrows noted. Unit as a whole

Locality 6—Continued

Northern part of Last Chance Range No. 1 section, measured about 1–3 miles southeast of Cucomungo Canyon, sec. 31 and 32 (unsurveyed), T. 7 S., R. 39 E., and sec. 24, T. 7 S., R. 38 E.—Con.

Deep Spring Formation and upper part of Reed—Continued

Upper member—Continued

27. Siltstone (50 percent)—Continued *Feet*
weathers to form steep slope. Thickness of unit not exact owing to faulting in upper part of unit. Possibly some strata (as much as 30 ft ?) could have been faulted out, but exact amount is not determinable---------- 138
26. Dolomite, yellowish-gray (5*Y* 8/1); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline; structureless (faint suggestion of thin beds in places); weathers to form brown ledge---------------------------- 8
25. Silty limestone (80 percent) and siltstone (20 percent). Silty limestone, light-olive-gray (5*Y* 6/1); weathers olive gray (5*Y* 4/1); contains coarse silt and minor very fine sand grains; grades to limy siltstone in places; very thin to thin bedded. Siltstone, yellowish-gray (5*Y* 8/1) to greenish-gray (5*GY* 6/1); weathers same colors and dark yellowish brown (10*YR* 4/2); coarse silt; occurs in layers ½–2 in. thick interstratified with silty limestone. Unit as a whole weathers to form reentrant in cliff formed by units 24 and 26-- 8
24. Quartzite and minor siltstone. Quartzite, yellowish-gray (5*Y* 8/1); weathers same color; very fine to fine grained; evenly thinly laminated; common very low angle to low-angle cross-strata in top 10 ft. Siltstone; similar to that in underlying unit; occurs as 1-in. to 2-ft layers interstratified with quartzite in basal 16 ft of unit. Unit as a whole weathers to form ledge -------------------------------- 26
23. Siltstone, medium-dark-gray (*N*4) to olive-gray (5*Y* 4/1); weathers same colors; coarse silt; some laminated parts; not noticeably stratified in most places; weathers to form steep slope. Some very fine grained silty sandstone in basal 10 ft. This sandstone locally appears to be ripple laminated. An 8-in. light-brown-weathering silty dolomite occurs about 5 ft above base of unit------------------------------ 43

Total of upper member--------------- 284±

Offset in section so that overlying units measured 2⅓ miles northwest of underlying units.

Middle member:

22. Dolomite and limestone. Dolomite, very pale orange (10*YR* 8/2); weathers grayish orange (10*YR* 7/4); finely crystalline; laminated to thin bedded; forms top 6 ft of unit and occurs as 1–3-in. layers constituting about 25 percent of lower 7 ft of unit. Limestone; similar to that in unit 20. A dolomitic very fine grained sandstone layer about 4 in. thick occurs about 2 ft above base of unit. Unit weathers to form cliff------------------ 13

Locality 6—Continued

Northern part of Last Chance Range No. 1 section, measured about 1–3 miles southeast of Cucomungo Canyon, sec. 31 and 32 (unsurveyed), T. 7 S., R. 39 E., and sec. 24, T. 7 S., R. 38 E.—Con.

Deep Spring Formation and upper part of Reed—Continued
Middle member—Continued *Feet*

21. Siltstone (70 percent) and dolomite (30 percent). Siltstone, pale-yellowish-brown (10*YR* 6/2) and greenish-gray (5*GY* 6/1); Weathers dark yellowish brown (10*YR* 4/2); fine to medium silt; evenly laminated. Dolomite, medium-gray (*N*5); weathers light brown (5*YR* 6/4); very finely crystalline; occurs in 1–3-in. layers interstratified with siltstone. Unit as a whole weathers to form reentrant in cliff from units 20 and 22 ---------------- 5
20. Limestone, medium-gray (*N*5) and minor yellowish-gray (5*Y* 8/1) and light-gray (*N*7) (in places medium gray forms lenticular patches in lighter colored matrix); weathers same colors; very finely to finely crystalline; very thin bedded; some laminated parts; weathers to form cliff. About 50 percent of unit from 25 to 32 ft above base is pale-yellowish-brown (10*YR* 6/2) fine siltstone that occurs in layers ½–4 in. thick interstratified with limestone. A few 1–4-in. layers of light-brown (5*YR* 6/4) dolomite occur in basal 25 ft of unit ---------------- 37
19. Quartzite (40 percent) and siltstone (60 percent); lithologic types similar to those in unit 18, except for more gradational types between quartzite and siltstone; stratification is commonly wavy. Quartzite occurs in layers ½ in. to 1 ft thick interstratified with siltstone. Unit weathers to form steep slope. Unit as a whole weathers dark greenish gray (5*GY* 4/1) in contrast with underlying unit which weathers a lighter color ---------------- 162
18. Quartzite (70 percent) and siltstone (30 percent). Quartzite, yellowish-gray (5*Y* 8/1), pale-yellowish-brown (10*YR* 6/2), and medium-gray (*N*5); weathers same colors; very fine to fine grained; well sorted; limonitic in places; evenly thinly laminated, rare very low angle cross-strata; occurs as 1 in. to 4 ft thick layers interstratified with siltstone. Siltstone, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1); weathers same colors; fine to medium silt; some coarse silt layers grading to very fine grained silty sandstone; evenly and thinly laminated; occurs in ¼-in. to 2-ft layers interstratified with quartzite. Unit as a whole weathers to form steep slope. Grades into overlying unit across about 30 ft of beds. An 8-in. layer of dolomitic fine-grained sandstone occurs about 30 ft below top of unit ---------------- 148

Total of middle member ---------------- 365

NOTE.—Base of middle member uncertain; could be at top of unit 12.

Locality 6—Continued

Northern part of Last Chance Range No. 1 section, measured about 1–3 miles southeast of Cucomungo Canyon, sec. 31 and 32 (unsurveyed), T. 7 S., R. 39 E., and sec. 24, T. 7 S., R. 38 E.—Con.

Deep Spring Formation and upper part of Reed—Continued *Feet*

Offset in section so that overlying units measured ½ mile south of underlying units.

Carbonate unit:

NOTE.—Carbonate unit is probably correlative to lower member of Deep Spring Formation and upper member of Reed Dolomite, although here the contact between these two formations cannot be located. Also, as noted above, the base of the middle member of the Deep Spring Formation could be at the top of unit 12, in which case the carbonate unit would also include some middle member in its upper part.

17. Limestone, and dolomite in top 8 ft. Limestone, very pale orange (10*YR* 8/2); lower 9 ft is medium light gray (*N*6), with blotches and streaks of medium dark gray (*N*4); a 2-ft medium-light-gray layer is found 15 ft below top of unit. Limestone is very finely crystalline, indistinctly laminated to very thin bedded, has some very low angle cross-strata (in lower 9 ft). Dolomite, very pale orange (10*YR* 8/2) to pale-yellowish-brown (10*YR* 6/2); weathers grayish orange (10*YR* 7/4); medium to, very coarsely crystalline; indistinct laminae to very thin beds. Unit as a whole weathers to form cliff -- 38
16. Limy sandstone, in basal 12 ft and top 3 ft, sandstone and siltstone in rest of unit. Limy sandstone, grayish-yellow (5*Y* 8/4) to yellowish-gray (5*Y* 7/2); weathers moderate yellowish-brown (10*YR* 5/4); very fine grained; laminated to very thin bedded; some very low angle cross-strata. Sandstone, medium-dark-gray (*N*4) to olive-gray (5*Y* 4/1); weathers same colors; very fine grained; laminated in some places; occurs in middle of unit; poorly exposed. Some siltstone crops out near top of unit, but the siltstone is poorly exposed. Siltstone, olive-gray (5*Y* 4/1); weathers same colors; medium silt; micaceous. Top 30 ft of unit poorly exposed. Unit as a whole forms rubble-covered slope ---------------- 43
15. Limestone (95 percent) and siltstone (5 percent). Limestone, grayish-orange (10*YR* 7/4) to dark-yellowish-orange (10*YR* 6/6); uncommon medium light gray (*N*6) thin beds and irregular mottles locally; weathers same colors; very finely to finely crystalline; pisolites as large as ¼ in. across in top 5 ft; beds ½–6 in. thick. Bedding is a noticeable feature of unit. Siltstone, greenish-gray (5*GY* 6/1) to light-olive-gray (5*Y* 6/1); weathers same colors; fine to medium silt; occurs as ½–6 inch layers interstratified with limestone. Unit as a whole weathers to form cliff ---------------- 110
14. Quartzite (90 percent) and siltstone (10 percent). Quartzite, olive-gray (5*Y* 4/1) to medium-gray (*N*5), and pale-yellowish-brown

Locality 6—Continued

Northern part of Last Chance Range No. 1 section, measured about 1–3 miles southeast of Cucomungo Canyon, sec. 31 and 32 (unsurveyed), T. 7 S., R. 39 E., and sec. 24, T. 7 S., R. 38 E.—Con.

Deep Spring Formation and upper part of Reed—Continued
Carbonate unit—Continued

Feet

14. Quartzite (90 percent)—Continued (10*YR* 6/2); weathers same colors; very fine grained; micaceous; structureless. Siltstone, medium-gray (*N*5); fine silt; micaceous; poorly exposed; amount uncertain. Unit poorly exposed in places; weathers to form rubble-covered slope — 43
13. Covered; form slope — 11
12. Limestone and dolomite. Limestone, medium-gray (*N*5) to light-medium-gray (*N*6); weathers same colors; finely crystalline; very thin to thin bedded. Dolomite, medium-light-gray (*N*6) and pale-yellowish-brown (10*YR* 6/2); weathers light brown (5*YR* 6/4); finely to medium crystalline. Along line of section, limestone occurs in basal 17 ft and dolomite in rest of unit, but lateral to line of section, unit is locally all limestone. Dolomite apparently is alteration of limestone. Unit as a whole weathers to form a cliff — 62
11. Mostly covered. Outcrops of sandy limestone in middle and in top 4 ft of unit. Sandy limestone, medium-gray (*N*5) with minor pale-yellowish-brown (10*YR* 6/2); weathers grayish orange (10*YR* 7/4); very fine to fine quartz grains set in line matrix; wavy laminae to very thin beds. Unit weathers to form rubble-covered slope — 15
10. Dolomite, medium-light-gray (*N*6); weathers dark yellowish orange (10*YR* 6/6); very finely crystalline; no internal stratification noted; weathers to form prominent dark-yellowish-orange ledge — 5
9. Limestone, medium-gray (*N*5); some grayish orange (10*YR* 7/4) in lower 8 ft and rarely elsewhere in unit; weathers medium gray (*N*5) except for dark yellowish orange (10*YR* 6/6) to grayish orange (10*YR* 7/4) in lower 8 ft of unit and a few other thin beds higher in unit; very finely crystalline; thin to thick bedded; weathers to form cliff with prominent grayish-orange color band at base. A few 1–6-in. layers of pale-yellowish-brown (10*YR* 6/2) coarse micaceous siltstone occur in unit — 46
8. Sandy limestone to limestone (15 percent), quartzite (50 percent), and siltstone (55 percent). Sandy limestone to limestone, medium-gray (*N*5); weathers same color and minor dark yellowish brown (10*YR* 4/2); composed of very fine grained quartz grains set in lime matrix; all gradations from almost pure limestone to 50 percent sand; beds are wavy and ½–3 in. thick. Quartzite, yellowish-gray (5*Y* 8/1); weathers same color and grayish orange (10*YR* 7/4); very fine to fine grained; evenly laminated; occurs in layers 1 in. to 2

Locality 6—Continued

Northern part of Last Chance Range No. 1 section, measured about 1–3 miles southeast of Cucomungo Canyon, sec. 31 and 32 (unsurveyed), T. 7 S., R. 39 E., and sec. 24, T. 7 S., R. 38 E.—Con.

Deep Spring Formation and upper part of Reed—Continued
Carbonate unit—Continued

Feet

8. Sandy limestone to limestone—Continued ft thick interstratified with other lithologic types. Siltstone, olive-gray (5*Y* 4/1) and pale-yellowish-brown (10*YR* 6/2); weathers same colors; coarse silt; micaceous; evenly laminated — 35

Offset in section so that overlying units measured 500± ft northwest of underlying units.

7. Sandy limestone (70 percent) and limestone (30 percent), medium-gray (*N*5) to light-gray (*N*7); weathers same colors and dark yellowish brown (10*YR* 4/2) (top 50 ft of unit has more gray-weathering rock than rest of unit); finely to medium crystalline; most of the limestone (70 percent) contains 10–50 percent very fine to medium subround quartz grains; all of limestone is very thin bedded to laminated, has common very low angle cross-strata, and weathers to form cliff. Top 50 ft of unit contains more nonsandy limestone, particularly gray-weathering limestone, than rest of unit. Unit contains a few 6-in. to 2-ft layers of greenish-gray siltstone in basal half and about 30 percent of the unit from 75 to 105 ft above the base is greenish-gray siltstone. Unit contains a 3-ft light-brown (5*YR* 6/4)-weathering dolomite about 30 ft above base. Near base, unit contains a 2-ft layer of limy sandstone somewhat similar to quartzite in underlying unit. Unit is highly contorted in places, and although the unit is not broken by any faults of large displacement, the thickness of the unit could be in error by 20 or 30 percent — 155
6. Quartzite (60 percent) and siltstone (40 percent). Quartzite, pale-yellowish-brown (10*YR* 6/2); weathers same color and light brown (5*YR* 6/4); fine grained; some medium grains; evenly laminated. Siltstone, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1); weathers same colors; micaceous; coarse silt; evenly laminated; occurs as 1–8-in. layers interstratified with quartzite. Unit as a whole weathers to form slope. Unit may be tectonically thinned — 35

Offset in section so that overlying units measured 500± ft northwest of underlying units.

5. Limestone, light-gray (*N*7) to medium-light-gray (*N*6) (commonly light-gray (*N*7) parts have irregular blotches and streaks of medium gray (*N*5)); some grayish orange (10*YR* 7/4) from 22 to 57 ft weathers same colors; finely to medium crystalline; oolitic (no internal structure seen) in top 10 ft; indistinctly very thin to thin bedded; weathers to form ledge. Greenish-gray (5*GY* 6/1) siltstone occurs as a few 1–6 in. layers in basal 5 ft and

Locality 6—Continued

Northern part of Last Chance Range No. 1 section, measured about 1–3 miles southeast of Cucomungo Canyon, sec. 31 and 32 (unsurveyed), T. 7 S., R. 39 E., and sec. 24, T. 7 S., R. 38 E.—Con.

Deep Spring Formation and upper part of Reed—Continued
Carbonate unit—Continued

	Feet
5. Limestone, light-gray—Continued as 1-ft-thick beds from 53 to 54 ft, and 55 to 57 ft above base of unit. Unit has threefold division: 0–22 ft, mostly cliff-forming gray-weathering limestone; 22–57 ft, gray- and grayish-orange-weathering reentrant-forming limestone with some siltstone near top; 57–77 ft, gray-weathering cliff-forming limestone with 3-ft grayish-orange band at top	77
4. Siltstone (60 percent) and quartzite (40 percent). Siltstone, olive-gray (5*Y* 4/1); weathers same color; medium silt; some mica; platy cleavage at angle to stratification. Quartzite, pale-yellowish-brown (10*YR* 6/2); weathers same colors; fine grained; evenly laminated; occurs in 2–12-in. layers interstratified with siltstone. Unit as a whole weathers to form slope	25
3. Limestone to sandy limestone (70 percent), quartzite (15 percent), and siltstone (15 percent). Limestone to sandy limestone, medium-gray (*N*5) and rare grayish-orange (10*YR* 7/4); weathers same colors; abundant grayish-orange-weathering color from 10 to 15 ft above base of unit; finely to medium crystalline; 10–50 percent rounded fine to coarse quartz grains in most parts; indistinct very thin beds; abundant very low angle cross-strata in the sandy limestone. Quartzite and siltstone; similar to those in underlying unit; occur in 1-in. to 1-ft layers interstratified with the other lithologic types. Unit as a whole weathers to form slope except basal 15 ft, which forms a ledge	87±
Total of carbonate unit	787±

Quartzite and siltstone unit (incomplete; probably correlative of Hines Tongue of Reed Dolomite):

	Feet
2. Quartzite (40 percent), limestone (30 percent), and siltstone (30 percent). Quartzite, pale-yellowish-brown (10*YR* 6/2) and minor medium-gray (*N*5); weathers dominantly dark yellowish brown (10*YR* 6/2); fine grained; micaceous in places; evenly laminated; occurs in layers 1 in. to 2 ft thick interstratified with other lithologic types. Limestone, medium-gray (*N*5) to dark-gray (*N*3) and minor grayish-orange (10*YR* 7/4); weathers dark brownish gray (10*YR* 4/2) to light brown (5*YR* 6/4) and medium gray (*N*5); medium crystalline; laminated to very thin bedded; rare low-angle cross-strata; occurs in layers 6 in. to 3 ft thick; grades into quartzite in places; lowest limestone is 25 ft above base of unit. Siltstone, greenish-gray (5*GY* 6/1); weathers same color; fine to medium silt; micaceous; occurs in layers 1 in.	

Locality 6—Continued

Northern part of Last Chance Range No. 1 section, measured about 1–3 miles southeast of Cucomungo Canyon, sec. 31 and 32 (unsurveyed), T. 7 S., R. 39 E., and sec. 24, T. 7 S., R. 38 E.—Con.

Deep Spring Formation and upper part of Reed—Continued
Quartzite and siltstone unit—Continued

	Feet
2. Quartzite (40 percent)—Continued to 6 ft thick. Unit grades into underlying unit. Unit as a whole weathers to form cliff. Top 6 ft of unit is siltstone	87
1. Quartzite (50 percent) and siltstone (50 percent). Quartzite, pale-yellowish-brown (10*YR* 6/2); some reddish tint; weathers same colors; fine to medium grained; evenly laminated; occurs as layers 3 in. to 2 ft thick interstratified with siltstone. Siltstone, dark-greenish-gray (5*GY* 4/1) to medium-dark-gray (*N*4); weathers same colors; medium to coarse silt; micaceous; platy cleavage; occurs in layers of comparable thickness to the quartzite. Unit as a whole weathers to form steep slope	40±
Total of incomplete quartzite and siltstone unit	127±
Total of Deep Spring Formation and upper part of Reed(?) Dolomite	1,563±

Base of section; strata to south, which are apparently lower stratigraphically than unit 1, are contorted and thicknesses cannot be measured. Probably several hundred feet of strata similar to unit 1 occur in this structurally complex area, however.

Locality 7 (section 1)

Southern part of Last Chance Range No. 1 section, measured on cliff on west side of the Last Chance Range, at south end of Eureka Valley, 2 miles east of Sand Dunes. About 1½ miles S. 80° W. of hill 6886, SE¼ sec. 7 (unsurveyed) and SW¼ sec. 8 (unsurveyed), T. 10 S., R. 40 E.

[Measured by J. H. Stewart and S. D. Stewart, April 1963]

Top of section; not top of exposure.
Carrara Formation (incomplete):

	Feet
14. Limestone, medium-gray (*N*5) to light-medium-gray (*N*6); weathers light medium gray (*N*6) and light brown (5*YR* 6/4); finely crystalline; commonly contains abundant coarse silt and very fine grained sand; irregular beds ¼–3 in. thick; weathers to form ledge. Unit not measured but is estimated to be about 25 ft thick and is overlain by greenish-gray siltstone	Unmeasured
13. Quartzite and siltstone. Quartzite, yellowish-gray (5*Y* 8/1) and rare pale-yellowish-brown (10*YR* 6/2); weathers same colors and dark-yellowish-brown (10*YR* 4/2); very fine to fine grained; rarely medium to coarse grained; fairly well to well sorted; composed of subround clear quartz; possibly some dolomitic parts; irregular and gnarly beds ¼ in. to 2 ft thick; some evenly laminated parts; rare very low angle small-scale cross-strata. Siltstone, dark-greenish-gray (5*GY*	

Locality 7 (section 1)—Continued

Southern part of Last Chance Range No. 1 section, measured on cliff on west side of the Last Chance Range, at south end of Eureka Valley, 2 miles east of Sand Dunes. About 1½ miles S. 80° W. of hill 6886, SE¼ sec. 7 (unsurveyed) and SW¼ sec. 8° (unsurveyed), T. 10 S., R. 40 E.—Continued

	Feet
Carrara Formation (incomplete)—Continued	
13. Quartzite and siltstone—Continued 4/1), medium-dark-gray ($N4$) and light-olive-gray ($5Y$ 6/1); weathers same colors; fine to coarse silt; platy splitting. Siltstone constitutes about 50 percent of basal 17 ft of unit, where it occurs interstratified with ½-in. to 2-ft layers of quartzite. Siltstone occurs rarely as ⅛–½-in. layers in rest of unit. Quartzite forms almost white color band from 8 to 16 ft below top of unit. Unit as a whole weathers to form steep ledgy slope	87
Total of incomplete Carrara Formation	87
Zabriskie Quartzite:	
12. Quartzite, medium-light-gray ($N6$), medium-dark-gray ($N4$) to grayish-purple ($5P$ 4/2), rare pale-red ($5R$ 6/2); weathers same colors and dusky yellowish brown ($10YR$ 4/2); fine to medium grained; some coarse-grained parts; fairly well sorted; composed of subround clear quartz; massive splitting; laminated to beds as large as 1 in.; common 2–5-in.-thick tabular planar(?) sets of small-scale low-angle cross-strata; stratification emphasized by color bands (different shades of gray and purple) a few millimeters to a centimeter thick. Unit weathers to form steep slope containing some cliffy parts. Top 17 ft of unit is yellowish-gray ($5Y$ 8/1) and medium-light-gray ($N6$) very thin bedded to laminated dark-yellowish-brown ($10YR$ 4/2)-weathering fine- to medium-grained quartzite that forms darker colored cap to unit and appears to be a transitional into overlying unit. *Scolithus* tubes noted in 1-ft-thick bed 944 ft above base of unit. Fault of unknown displacement occurs at 953 ft above base of unit. This fault can be seen to extend for 1,500 ft or more to the north and at least a comparable distance to the south	1,276
11. Quartzite (85 percent) and siltstone (15 percent). Quartizite, yellowish-gray ($5Y$ 8/1) to pale-yellowish-brown ($10YR$ 6/2); rare greenish gray ($5GY$ 6/1) in lower 20 ft; weathers same colors and dark yellowish brown ($10YR$ 4/2); fine to medium grained; rare coarse-grained parts; fairly well to well sorted; evenly laminated to thin bedded; thin tabular planar sets of medium- to small-scale cross-strata (cross-strata constitute about 50 percent of unit). Siltstone, greenish-gray ($5GY$ 6/1) to dark-greenish-gray ($5GY$ 4/1); weathers same colors; fine to medium silt; platy cleavage at angle to bedding; occurs in 1–10-in. sets interstratified with quartzite. Unit as a whole weathers to form ledgy cliff. Contact	

Locality 7 (section 1)—Continued

Southern part of Last Chance Range No. 1 section, measured on cliff on west side of the Last Chance Range, at south end of Eureka Valley, 2 miles east of Sand Dunes. About 1½ miles S. 80° W. of hill 6886, SE¼ sec. 7 (unsurveyed) and SW¼ sec. 8° (unsurveyed), T. 10 S., R. 40 E.—Continued

	Feet
Zabriskie Quartzite—Continued	
11. Quartzite (85 percent) etc.—Continued with overlying unit marked by thin fault breccia; fault is probably of small displacement	88
Total of Zabriskie Quartzite	1,364
Wood Canyon Formation (incomplete):	
10. Siltstone and quartzite. Siltstone, dark-greenish-gray ($5GY$ 4/1) and minor greenish-gray ($5GY$ 6/1); weathers same colors and greenish black ($5GY$ 2/1); fine to medium silt; platy cleavage obscures bedding. Quartzite, greenish-gray ($5GY$ 6/1), light-greenish-gray ($5GY$ 8/1), and pale-yellowish-brown ($10YR$ 6/2); weathers dark yellowish brown ($10YR$ 4/2); very fine to fine grained; well sorted; evenly laminated to thin bedded; rare low-angle cross-strata in top 15 ft. Quartzite is absent in lower third of unit, constitutes 10 percent of middle third, and increases gradually in amount upward in unit to about 90 percent of strata in top 15 ft of unit; top 40 ft of unit totals about 50 percent quartzite. Unit transitional at top into overlying unit. Contact placed at change from greenish-gray dark-yellowish-brown-weathering quartzite below to yellowish-gray-weathering quartzite above. Contact from distance marked by color change, although in detail is transitional over probably 40 ft of strata. Unit as a whole weathers to form ledgy cliff and greenish interval between light-colored units above and below. Trilobites which are possibly in part *Paedeumias* (USGS colln. 4242–CO identified by A. R. Palmer, written commun., 1963) collected in this unit about 1,500 ft north of line of section	124
Equivalent of Poleta Formation:	
9. Limestone, medium-dark-gray ($N4$); weathers same color with light-brown ($5YR$ 6/4) mottles and irregular lenses; very finely to finely crystalline; indistinct and wavy very thin to thin beds; weathers to form minor ledge. Bottom 9 ft contains some yellow-gray quartzite similar to underlying unit, and limestone commonly contains very fine sand. Top 4 ft of unit contains some silty limestone and grades into overlying units. Light-brown mottles occur only on surface of rock and do not fizz in acid; they are either a dolomitic weathering product or accumulations of clastic (silty) material	28
8. Quartzite, pale-yellowish-brown ($10YR$ 6/2), yellowish-gray ($5Y$ 8/1), and minor medium-gray ($N5$); weathers moderate yel-	

Locality 7 (section 1)—Continued

Southern part of Last Chance Range No. 1 section, measured on cliff on west side of the Last Chance Range, at south end of Eureka Valley, 2 miles east of Sand Dunes. About 1½ miles S. 80° W. of hill 6886, SE¼ sec. 7 (unsurveyed) and SW¼ sec. 8° (unsurveyed), T. 10 S., R. 40 E.—Continued

Wood Canyon Formation (incomplete)—Continued
Equivalent of Poleta Formation—Continued

	Feet
8. Quartzite, pale-yellowish-brown etc.—Con. lowish brown (10*YR* 5/4) and dark yellowish brown (10*YR* 4/2); three yellowish-gray (5*Y* 8/1) bands 6–16 ft thick; very fine grained; well sorted; evenly laminated to thin bedded; rare very low angle cross-strata; weathers to form ledgy cliff. *Scolithus* tubes abundant in most of unit. Three prominent intervals of light-colored dominantly yellowish-gray (5*Y* 8/1) quartzite occur from 41 to 53 ft, from 85 to 101 ft, and from 130 to 136 ft above base of unit. A few thin sets of dark-greenish-gray siltstone occur in lowest 30 ft of unit. Unit measured in area of many small faults. Thickness of unit may be in error by as much as 20± ft	194±
7. Siltstone (70 percent) and quartzite (30 percent). Siltstone dark-greenish-gray (5*GY* 4/1) to medium-gray (*N*5); weathers same colors; fine to coarse silt; indistinctly laminated to very thin bedded. Quartzite, pale-yellowish-brown (10*YR* 6/2), yellowish-gray (5*Y* 8/1), and minor medium-gray (*N*5); weathers same colors and dark yellowish brown (10*YR* 4/2); very fine grained; well sorted; evenly laminated; rare very low angle cross-strata; occurs in sets 1 in. to 4 ft thick; some layers have wavy lower surface apparently caused by minor scouring. Quartzite forms almost all of basal 22 ft of unit and is abundant in upper 40 ft of unit; elsewhere quartzite constitutes 10–20 percent of rock. Limestone occurs as several very thin beds in basal 22 ft of unit and as conspicuous dark-yellowish-brown-weathering unit from 101 to 103 ft above base of unit. These limestone units contain pelmatozoa debris. *Scolithus* tubes and worm trails are fairly common in unit. Unit as a whole weathers to form steep slope. Unit grades into overlying unit. Several small faults occur within unit but were avoided in measurement by transferring along limestone bed at 101 to 103 ft above base	152
6. Limestone, medium-gray (*N*5); weathers same color and moderate yellowish brown (10*YR* 5/4); latter color predominant in upper half of unit; composed of plates of pelmatozoa set in finely crystalline matrix (plates constitute about 20 percent of rock); laminated to very thin bedded; some waviness to bedding; weathers to form prominent brownish ledge	7

Locality 7 (section 1)—Continued

Southern part of Last Chance Range No. 1 section, measured on cliff on west side of the Last Chance Range, at south end of Eureka Valley, 2 miles east of Sand Dunes. About 1½ miles S. 80° W. of hill 6886, SE¼ sec. 7 (unsurveyed) and SW¼ sec. 8° (unsurveyed), T. 10 S., R. 40 E.—Continued

Wood Canyon Formation (incomplete)—Continued
Equivalent of Poleta Formation—Continued

	Feet
5. Siltstone (phyllitic) (75 percent), quartzite (20 percent), and limestone (5 percent). Siltstone, dark-greenish-gray (5*GY* to 4/1) to greenish-gray (5*GY* 6/1); weathers same colors and dusky yellowish brown (10*YR* 2/2); fine to coarse silt; laminated to very thin bedded. Quartzite, pale-yellowish-brown (10*YR* 6/2); weathers dusky yellowish-brown (10*YR* 2/2); very fine grained; well sorted; evenly laminated; rare very low angle cross-strata; occurs as 0.5–4-ft beds interstratified with siltstone; occurs almost entirely from 23 to 32 ft above base of unit and in top 50 ft of unit; constitutes about 40 percent of rock in these parts of unit. Limestone, medium-gray (*N*5) and pale-yellowish-brown (10*YR* 6/2); weathers same colors and moderate yellowish brown (10*YR* 5/4); finely to coarsely crystalline; common pelmatozoa debris; occurs in 3-in. to 2.5-ft layers interstratified with siltstone and quartzite. Possible archeocyathids noted in limestone within 50 ft of base of unit, 200 ft south of line of section. Limestone is irregularly distributed throughout unit. Unit as a whole weathers to form steep slope. Parallel ripple marks noted about 50 ft below top of unit and in middle of unit. Rocks of interval from 23 to 32 ft above base of unit form minor ledgy outcrop containing some quartzite and, from 24.0 to 26.5 ft a limestone layer. *Scolithus* tubes noted rarely in upper half of unit. Worm trails occur commonly in unit	178
4. Limestone (40 percent) and quartzitic siltstone (60 percent). Limestone, pale-yellowish-brown (10*YR* 6/2); weathers dark yellowish brown (10*YR* 4/2) and moderate yellowish brown (10*YR* 5/4); finely to coarsely crystalline; commonly composed mostly of pelmatozoa debris; occurs in beds 0.5–2.5 ft thick interstratified with quartzitic siltstone; contains peculiar cylindrical objects (fossils?) about ⅛–¼ in. in diameter and as long as 1 in. Quartzitic siltstone, pale-yellowish-brown (10*YR* 4/2), minor greenish-gray (5*GY* 6/1); weathers dominantly dark yellowish brown (10*YR* 4/2); coarse silt; wavy laminae to very thin beds; occurs interstratified with limestone. Unit weathers to form prominent ledgy outcrops. Some possible archeocyathids noted in this unit about 200 ft south of line of section	14

Locality 7 (section 1)—Continued

Southern part of Last Chance Range No. 1 section, measured on cliff on west side of the Last Chance Range, at south end of Eureka Valley, 2 miles east of Sand Dunes. About 1½ miles S. 80° W. of hill 6886, SE¼ sec. 7 (unsurveyed) and SW¼ sec. 8° (unsurveyed), T. 10 S., R. 40 E.—Continued

Wood Canyon Formation (incomplete)—Continued
Equivalent of Poleta Formation—Continued — *Feet*

3. Quartzitic siltstone (90 percent) and limestone (10 percent). Quartzitic siltstone, dark-greenish-gray (5*GY* 4/1) and medium-dark-gray (*N*4); weathers dusky yellowish brown (10*YR* 2/2); coarse siltstone; indistinctly very thin bedded to laminated; some waviness to bedding. Limestone, pale-yellowish-brown (10*YR* 6/2) to dark-yellowish-brown (10*YR* 4/2); weathers same colors and moderate yellowish brown (10*YR* 5/4); finely to coarsely crystalline; occurs in ½–8-in. beds interstratified with quartzitic siltstone; locally contains pelmatozoa debris and possible archeocyathids. Unit as a whole weathers to form steep slope. Unit contains a few thin beds of yellowish-gray (5*Y* 8/1) very fine grained laminated quartzite. Parallel ripple marks occur on one bedding plane near top of unit. One cephalon of a trilobite, possibly *Nevadella* (USGS colln. 4241–CO, identified by A. R. Palmer, written commun., 1963), found as float within basal 10 ft of unit about 1,500 ft north of line of section — 73
2. Limestone, very pale orange (10*YR* 8/2), yellowish-gray (5*Y* 8/1), and minor light-olive-gray (5*Y* 6/1); common irregular patches and mottles of light-brown (5*YR* 6/4) dolomite; weathers dominantly grayish orange (10*YR* 7/4); medium to coarsely crystalline; probably a recrystallized limestone or marble; indistinct stratification, probably is mostly very thin to thin bedded; weathers to form conspicuous light-colored cliff. Indistinct light-colored markings which are apparently distorted and recrystallized archeocyathids about ⅛–¼ in. in diameter; about 1,500 ft north on outcrop abundant archeocyathids were noted in this unit. Pelmatozoa debris, consisting mostly of small plates, is abundant in some parts of unit. Bottom 9 ft of unit may be structurally disturbed and contains two(?) ½–1-ft greenish-gray siltstone layers — 123

Total of equivalent of Poleta Formation — *769*

1. Quartzite (75 percent) and siltstone (25 percent). Quartzite, pale-yellowish-brown (10*YR* 6/2), yellowish-gray (5*Y* 8/1), and minor dark-yellowish-brown (10*YR* 4/2); weathers same colors; very fine grained; well sorted; evenly laminated; some very low angle cross-strata; some indistinctly bedded parts. Siltstone, phyllitic, dark-greenish-gray (5*GY* 4/1) to medium-gray (*N*5); weathers same colors; coarse silt; minor mica; cleavage at angle to stratification; indistinctly laminated in places. Quartzite occurs in 1-in. to 4-ft layers interstratified with ½-in. to 4-ft layers of siltstone. Unit as a whole weathers to form steep slope. Dark-yellowish-brown (10*YR* 4/2) limestone occurs from 230 to 231 ft and 290.0 to 290.5 ft above base of unit. Lower limestone contains rare archeocyathids about ⅓–¼ in. in diameter and abundant pelmatozoa debris. About 200 ft south of line of section, parallel ripple marks occur on about 10 different layers. The ripples have parallel crests generally about 1.5 in. apart. Worm trails and indistinct marks also occur on these ripple-marked layers. About 1,000 ft north of line of section, basal 75± ft of unit weathers dusky yellowish brown (10*YR* 2/2); contains some medium-gray very fine grained quartzite, and sparse siltstone — 407

Total of incomplete Wood Canyon Formation — 1,300

Base of section; base of exposure.

Locality 7 (section 2)

Southern part of Last Chance Range No. 2 section, measured in cliffs on west side of Last Chance Range at south end of Eureka Valley, 3 miles northeast of Sand Dunes. About 1¾ miles S. 28° W. of hill 7062 (Sandy), near mutual corner of secs. 29, 30, 31, and 32, all unsurveyed, T. 9 S., R. 40 E.

[Measured by J. H. Stewart, April 1963]

Top of section; not top of exposure.
Bonanza King Formation (incomplete): — *Feet*

28. Limestone, medium-gray (*N*5); weathers same color; very finely crystalline; indistinct wavy beds ½–1 in. thick; weathers to form cliff. From 20 to 22 ft above base of unit is medium-light-gray (*N*6) and light-olive-gray (5*Y* 6/1) limestone that weathers the same colors; some very thin layers in this interval weather light brown (5*YR* 6/4). Only basal 50 ft of unit examined — Unmeasured
27. Limestone; color banded (in beds 1–3 ft thick) medium gray (*N*5), light olive gray (5*Y* 6/1) and yellowish gray (5*Y* 8/1) in lower 15 ft;

Locality 7 (section 2)—Continued

Southern part of Last Chance Range No. 2 section, measured in cliffs on west side of Last Chance Range at south end of Eureka Valley, 3 miles northeast of Sand Dunes. About 1¾ miles S. 28° W. of hill 7062 (Sandy), near mutual corner of secs. 29, 30, 31, and 32, all unsurveyed, T. 9 S., R. 40 E.—Continued

	Feet
Bonanza King Formation (incomplete)—Continued	
27. Limestone; color banded etc.—Continued yellowish gray (5*Y* 8/1) in rest of unit; very finely to finely crystalline; evenly laminated in a few places; very thin to thick bedded in most places; forms base of cliff. Unit forms prominent white band near base of Bonanza King Formation	49
26. Limestone, medium-gray (*N*5); weathers same color with abundant (20 percent) light-brown (5*YR* 6/4) mottles and ¼–½-in. layers; very finely crystalline; indistinct beds ¼–1 in. thick; weathers to form steep slope. This unit is transitional from the Carrara Formation to the Bonanza King Formation, but is placed as the basal unit of the Bonanza King Formation because it lacks the brown-weathering silty limestone layers, such as those in the underlying unit, that characterize the top part of the Carrara Formation. White color bands in unit vary in thickness along outcrop. Fifty feet south of line of section, top 6 ft of unit grades laterally from yellowish-gray limestone into medium-gray limestone	103
Total of incomplete Bonanza King Formation	152
Carrara Formation:	
Upper member:	
25. Limestone (50 percent) and silty limestone to limy siltstone (50 percent). Limestone, medium-gray (*N*5), pale-yellowish-brown (10*YR* 6/2), and moderate-yellowish-brown (10*YR* 5/4); weathers same colors; some medium-gray parts have light-brown (5*YR* 6/4) mottles on weathered surfaces; very finely to finely crystalline; indistinctly laminated to very thin bedded. A few 4–6 in.-thick sets of small-scale cross-strata occur in the limestone. Silty limestone to limy siltstone, pale-yellowish-brown (10*YR* 6/2), moderate, yellowish-brown (10*YR* 5/4), and light-olive gray (5*Y* 6/1); medium to coarse silt; micaceous; indistinctly laminated to very thin bedded. Limestone occurs as ½-in. to 4-ft layers interstratified with silty limestone to limy siltstone layers ½ in. to 2 ft thick. All lithologic types occur from limestone to slightly limy siltstone. Unit as a whole weathers to form steep slope. Brown-weathering color of unit quite distinctive	115
Offset on top of unit 24 so that unit 25 measured 400 ft north of unit 24	
24. Limestone, medium-gray (*N*5); weathers same color with abundant light-brown (5*YR* 6/4) mottles and irregular layers; very finely crystalline; indistinct beds ¼–2 in. thick; weathers to form ledge. Unit gradational with underlying unit and arbitrarily separated from it. Unit is a more prominent and thicker layer of limestone than any in underlying unit	29
23. Limestone, medium-gray (*N*5) to medium-light-gray (*N*6), and minor olive-gray (5*Y* 4/1); weathers medium gray (*N*5 with 30 percent light brown (5*YR* 6/4) (light-brown-weathering color occur as mottles and irregular layers and is mostly restricted to three of four intervals several feet thick within unit); very finely crystalline; indistinct laminae to very thin beds; weathers to form steep ledgy slope. A 1-ft olive-gray silty limestone layer occurs at base of unit. A very pale orange (10*YR* 8/2) color band occurs from 31 to 40 ft above base of unit. This color band is prominent locally but is discontinuous along outcrop; locally the rocks in the entire interval from 31 to 40 ft are medium gray	122
22. Limestone, very pale orange (10*YR* 8/2); weathers same color; finely crystalline; indistinct very thin beds; weathers to form ledge. Forms prominent white band	25
21. Limestone (85 percent), silty limestone (12 percent), and siltstone (3 percent). Limestone, yellowish-gray (5*Y* 8/1) and grayish-yellow (5*Y* 8/4); medium gray (*N*5) from 98 to 101 ft and 113 to 118 ft above base of unit; weathers same colors (a few beds weather light brown (5*YR* 6/4)); finely to coarsely crystalline; evenly laminated to very thin bedded. Silty limestone, medium-light-gray (*N*6) to yellowish-gray (5*Y* 8/1); weathers same colors (some beds weather light brown); very finely crystalline; fine to medium silt; laminated to thin bedded; occurs as a few beds from 62 to 85 ft above base of unit and as a few beds in top 65 ft of unit. Siltstone, light-brownish-gray (5*YR* 6/1); weathers same color; medium to coarse silt; some mica. laminated; occurs as a layer from 62 to 66 ft above base of unit and as thin seams to 4-in. beds at rare intervals in top 97 ft of unit. Unit as a whole weathers to form steep slope. Forms prominent light-colored band between white color bands above and below. Unit is yellowish gray weathering in lower half and contains increasingly more light-brown-weathering layers in upper half	163
Total of upper member	454
20. Limestone, medium-gray (*N*5) to medium-light-gray (*N*6); very light gray (*N*8) from 80 to 101 ft above base of unit and yellowish gray	

Locality 7 (section 2)—Continued

Southern part of Last Chance Range No. 2 section, measured in cliffs on west side of Last Chance Range at south end of Eureka Valley, 3 miles northeast of Sand Dunes. About 1¾ miles S. 28° W. of hill 7062 (Sandy), near mutual corner of secs. 29, 30, 31, and 32, all unsurveyed, T. 9 S., R. 40 E.—Continued

Carrara Formation—Continued

Middle member:

	Feet
20. Limestone, medium-gray (*N*5) etc.—Con. (5*Y* 8/1), almost white, from 101 to 108 ft above base of unit; weathers same colors except abundant light-brown (5*YR* 5/6) mottles and irregular lenses occur from 23 to 24 ft, 27 to 31 ft, and 49 to 50 ft, and rarely elsewhere in unit; very finely crystalline; consists mostly of oolites (no internal structures seen) about 1 mm in diameter from 31 to 49 ft above base of unit; indistinct even beds ¼–4 in. thick; no noticeable stratification in places; weathers to form cliff with prominent white top. Limy siltstone to silty limestone occurs from 62 to 71 ft above base of unit; is light olive gray (5*Y* 6/1) to medium light gray (*N*6); weathers dominantly light brown (5*YR* 6/4); is evenly laminated; contains coarse silt and locally grades to a limy quartzitic siltstone	108
19. Limestone, medium-dark-gray (*N*5); weathers same color with abundant light-brown (5*YR* 6/4) mottles and irregular lenses and layers; very finely crystalline; indistinct wavy beds ½–6 in. thick; weathers to form steep ledgy slope. Common to abundant *Girvanella* ¼–1 in. in diameter in much of unit. Silty limestone occurs from 20 to 39 ft; is medium gray (*N*5) to olive gray (5*Y* 4/1); weathers light brown (5*YR* 6/4); is otherwise similar to limestone in rest of unit	143
18. Limy siltstone, light-olive-gray (5*Y* 6/1) to medium-light-gray (*N*6); weathers pale yellowish brown (10*YR* 6/2); fine silt; limy; micaceous; indistinctly laminated to very thin bedded; weathers to form slope	23
17. Limestone, medium-light-gray (*N*6) to medium-gray (*N*5); weathers same colors with light-brown (5*YR* 5/6) mottles; very finely crystalline; wavy beds ¼–2 in. thick; weathers to form ledge	44
16. Phyllitic siltstone, and limestone to silty limestone. Phyllitic siltstone, greenish-gray (5*GY* 6/1) and minor light-olive-gray (5*Y* 6/1); weathers same colors and minor dusky yellowish brown (10*YR* 2/2); fine to medium silt; micaceous; evenly laminated to very thin bedded; some platy cleavage at angle to bedding. Limestone to silty limestone, medium-light-gray (*N*6); weathers same color and olive gray (5*Y* 4/1); very finely crystalline; wavy beds ¼–2 in. thick; occur as three layers—from 0 to 5 ft, from 10 to 13 ft, and from 18 to 32 ft above base of unit. Unit as a whole weathers to form ledgy slope	45

Locality 7 (section 2)—Continued

Southern part of Last Chance Range No. 2 section, measured in cliffs on west side of Last Chance Range at south end of Eureka Valley, 3 miles northeast of Sand Dunes. About 1¾ miles S. 28° W. of hill 7062 (Sandy), near mutual corner of secs. 29, 30, 31, and 32, all unsurveyed, T. 9 S., R. 40 E.—Continued

Carrara Formation—Continued

Middle member—Continued

	Feet
15. Phyllitic siltstone, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1), and minor light-olive-gray (5*Y* 6/1) and medium-gray (*N*5); weathers dominantly greenish gray (5*GY* 6/1); fine to medium silt; micaceous; laminated to very thin bedded; platy cleavage at an angle to stratification; weathers to form gentle slope. Pale-yellowish-brown (with locally medium-gray (*N*5) mottling) limestone that weathers moderate yellowish brown (10*YR* 5/4) occurs from 4 to 5 ft, 33.0 to 33.5 ft, 110.0 to 110.5 ft, and 111.5 to 112.5 ft above base of unit. A few small faults with 2–4 ft displacement noted in unit; these faults would make measured thickness slightly excessive	196
Total of middle member	559

Offset in section so that unit 15 is measured 400 ft north of unit 14.

Lower member:

14. Limestone, medium-dark-gray (*N*4) with minor medium-light-gray (*N*6) mottles; weathers medium light gray (*N*6) with minor olive-gray (5*Y* 4/1) mottles; very finely to finely crystalline; wavy beds ½–6 in. thick; weathers to form cliff. *Girvanella* in places throughout unit. Some minor faults in unit. Thickness probably accurate to within 20± ft	198
13. Limestone to silty limestone, medium-dark-gray (*N*5) to olive-gray (5*Y* 4/1); weathers same colors; very finely crystalline; silty in about half of unit; platy cleavage in silty parts; very thin irregular beds in limestone parts; weathers to form slope. Unit poorly exposed and strata somewhat contorted, probably owing to movement below overlying competent unit	23
12. Limestone, medium-dark-gray (*N*4); weathers same color with common light-brown (5*YR* 5/6) mottles and irregular layers ⅛–½ in. thick; very finely crystalline; irregular and indistinct beds ½–3 in. thick; weathers to form ledge	20
11. Phyllitic siltstone (80 percent) and limestone (20 percent). Phyllitic siltstone, medium-gray (*N*5); weathers same color; micaceous; irregular platy cleavage; commonly limy and grades to limestone. Limestone, dark-gray (*N*3); weathers same color and dark yellowish brown (10*YR* 4/2); very finely crystalline; very thin bedded; occurs in 0.5–2 ft layers interstratified with phyllitic siltstone.	

Locality 7 (section 2)—Continued

Southern part of Last Chance Range No. 2 section, measured in cliffs on west side of Last Chance Range at south end of Eureka Valley, 3 miles northeast of Sand Dunes. About 1¾ miles S. 28° W. of hill 7062 (Sandy), near mutual corner of secs. 29, 30, 31, and 32, all unsurveyed, T. 9 S., R. 40 E.—Continued

	Feet
Carrara Formation—Continued	
Lower member—Continued	
11. Phyllitic siltstone (80 percent) etc.—Continued Unit as a whole weathers to form slope and is poorly exposed in most places	39
10. Limestone, medium-gray (*N*5) and minor olive-gray (5*Y* 4/1); weathers medium gray with common light-brown (5*YR* 5/6) mottles and irregular layers; very fine crystalline; indistinct beds ½-in. to 1 ft thick; weathers to form ledge. Scattered *Girvanella* in some parts of unit	44
Offset in section so that unit 10 measured 200 ft. southeast of unit 9.	
9. Limestone (70 percent) and phyllitic siltstone to limy siltstone (30 percent). Limestone, medium-light-gray (*N*6) to medium-dark-gray (*N*4); weathers same colors with abundant light-brown (5*YR* 6/4) layers ⅛–1 in. thick; very finely crystalline; in beds ¼–2 in. thick. Phyllitic siltstone to limy siltstone, medium-light-gray (*N*6); weathers same color; fine silt; micaceous; platy cleavage. Silty strata most common in basal half of unit grading up into continuous limestone in top 25 ft of unit. *Girvanella* noted in limestone about 5 ft. above base of unit. Trilobite spines abundant in 1-in. limestone layer about 1 ft above base of unit. Unit as a whole weathers to form steep slope	68
8. Limestone, dark-gray (*N*3) and minor medium-gray (*N*5); weathers same colors and light brown (5*YR* 6/4) (light brown occurs as irregular patches and mottles); very finely crystalline; indistinct beds 1–3 in. thick; weathers to form ledge. Unit forms re-entrant from 7 to 10 ft above base and is silty in this interval. Some *Girvanella* at top of unit	24
7. Limestone (50 percent) to limy siltstone (50 percent); medium light-gray (*N*4) in limy parts to pale yellowish brown (10*YR* 6/2) and light brown (5*YR* 6/4) in silty parts; weathers same colors; fine silt; finely to coarsely crystalline; laminated to very thin bedded. All gradations from limestone, silty limestone, to limy siltstone. Unit as a whole weathers to form slope. Unit is silty at base and grades up into a limy unit which is transitional with overlying unit	47
6. Phyllitic siltstone; same as unit 4; grades into overlying unit	10
5. Limestone, pale-yellowish-brown (10*YR* 6/2) to moderate-yellowish-brown (10*YR* 5/4); weathers same colors; finely crystalline; about half of unit is composed of pisolites (no internal structure seen) 3–5 mm in diameter set in finely crystalline matrix; beds 1–3 in. thick; weathers to form ledge	8
4. Phyllitic siltstone, greenish-gray (5*GY* 6/1); weathers same color; micaceous; coarse(?) silt; platy cleavage at angle to stratification; some laminated parts noted. A 0.5 ft light-brown (5*YR* 6/4) limestone occurs from 5.0 to 5.5 ft above base of unit	29
3. Limestone to dolomitic limestone, medium-gray (*N*5) to medium-dark-gray (*N*5), and minor pale-yellowish-brown (10*YR* 6/2); weathers medium-gray (*N*5) and light brown (5*YR* 6/4); finely to medium crystalline; beds ½–2 in. thick; weathers to form ledge. Unit is greenish-gray phyllitic coarse siltstone from 25 to 28 ft above base and yellowish-gray (5*Y* 8/1) to pale yellowish-brown (10*YR* 6/2) fine-grained quartzite from 28 to 29 ft. Limestone in top 3 ft of unit contains abundant fine to coarse well-rounded quartz grains	32
2. Quartzite (85 percent) and phyllitic siltstone (15 percent). Quartzite, pale-yellowish-brown (10*YR* 6/2) to dark-yellowish-brown (10*YR* 4/2), and yellowish-gray (5*Y* 8/1); weathers dominantly dark yellowish brown (10*YR* 4/2); very fine to fine grained; commonly appears to be dolomitic; rare medium- to coarse-grained parts; laminated to beds 1.5-ft thick. Phyllitic siltstone, light-gray (*N*7), yellowish-gray (5*Y* 8/1) and pale-yellowish-brown (10*YR* 6/2); weathers same colors; fine to coarse silt; platy splitting; occurs at 2-in. to 4-ft layers interstratified with quartzite. Phyllitic siltstone is mostly in lower half of unit. A dark-yellowish-brown (10*YR* 4/2) sandy limestone occurs from 17 to 18 ft above base of unit; sand is medium to coarse. Prominent nearly white quartzite occurs from 78 to 85 ft above base of unit	88
Total of lower member	630
Total of Carrara Formation	1,643
Zabriskie Quartzite:	
1. Quartzite, yellowish-gray (5*Y* 8/1), medium-gray (*N*5), and grayish-purple (5*P* 4/2); weathers same colors; fine to medium grained; scattered coarse grains; laminated to very thin bedded; highly fractured. About 200 ft exposed at base of cliff	Unmeasured
Base of section; base of exposure.	

Locality 10

Indian Pass section, measured in Funeral Mountains about ½–2 miles west of Indian Pass. Units 1–14 measured starting in southeastern part of sec. 25, T. 29 N., R. 1 E., and ending in north-central part of sec. 31 (unsurveyed), T. 29 N., R. 2 E. Units 15–25 measured in east-central part of sec. 30 (unsurveyed) and west-central part of sec. 29 (unsurveyed), T. 29 N., R. 2 E.

[Measured by J. H. Stewart, March 1965]

Stirling Quartzite (incomplete):

A member (incomplete): *Feet*

25. Quartzite, yellowish-gray (5*GY* 8/1), fine- to medium-grained, thin-bedded; minor medium-scale cross-strata; weathers to form cliff. This unit is about 75 ft thick and gives way upward into fine-grained greenish-gray (5*GY* 6/1) quartzite. This latter quartzite underlies flat area at top of cliff — Unmeasured
24. Quartzite and minor mica schist in lower third. Quartzite, light-gray (*N*7) with purplish cast and light-greenish-gray (5*GY* 8/1), fine- to medium-grained, thin-bedded and thin tabular planar sets of low-angle cross-strata. Mica schist, greenish-gray (5*GY* 6/1), finely crystalline; occurs in 6-in. to 2-ft layers in lower third of unit. Unit weathers to form slope — 50
23. Mica schist (60 percent) and quartzite (40 percent). Mica schist, greenish-gray (5*GY* 6/1), finely crystalline. Quartzite, medium-light-gray (*N*6) to greenish-gray (5*GY* 6/1), fine- to medium-grained; some dolomitic and dark-yellowish-brown (10*YR* 4/2)-weathering parts; very thin bedded; occurs in 6-in. to 2-ft layers. Quartzite occurs only in lower 30 ft of unit. Unit weathers to form slope — 37±
22. Dolomite, very pale orange (10*YR* 8/2), rare light-olive-gray (5*Y* 6/1); weathers grayish orange (10*YR* 7/4); very finely crystalline to aphanitic; very thin bedded; weathers to form prominent orange ledge. Unit contains a few thin silty(?) dolomite layers and a few thin phyllite layers. Same as unit 2 in Lees Camp section (loc. 58) — 30±
21. Mica schist (85 percent) and quartzite (15 percent). Mica schist, greenish-gray (5*GY* 6/1), light-gray (*N*7), and pale-red (10*R* 6/2), finely crystalline; well-defined schistosity. Quartzite, pinkish-gray (5*YR* 8/1) and yellowish-gray (5*Y* 8/1), fine- to medium-grained; rare medium-grained to very coarse grained parts; occurs as 4–12-in. layers. Unit weathers to form slope — 102
20. Quartzite, light-gray (*N*7), rare light-greenish-gray (5*GY* 8/1), and pinkish-gray (5*YR* 8/1), fine- to medium-grained; common medium-grained to very coarse grained parts; rare conglomeratic parts

Locality 10—Continued

Indian Pass section, measured in Funeral Mountains about ½–2 miles west of Indian Pass. Units 1–14 measured starting in southeastern part of sec. 25, T. 29 N., R. 1 E., and ending in north-central part of sec. 31 (unsurveyed), T. 29 N., R. 2 E. Units 15–25 measured in east-central part of sec. 30 (unsurveyed) and west-central part of sec. 29 (unsurveyed), T. 29 N., R. 2 E.—Con.

Stirling Quartzite (incomplete)—Continued

A member (incomplete)—Continued

20. Quartzite, light-gray (*N*7) etc.—Continued *Feet*
with granules and pebbles (as large as 0.4 in.) of quartz and quartzite(?); very thin to thin bedded; common thin to thick tabular planar sets of cross-strata; weathers to form cliff. Unit contains a few 6-in. to 3-ft-thick layers of greenish-gray (5*GY* 6/1) phyllite — 365

Section transferred on top of unit 19 so that overlying units measured 400 ft north of unit 19.

19. Phyllite to schist (70 percent) and quartzite (30 percent). Phyllite to schist; greenish-gray (5*GY* 6/1) and rare pale-red (5*R* 6/2) in lower one-fourth of unit; medium-crystalline mica schist in upper half of unit contains prismatic crystals of staurolite(?) as long as half an inch. Quartzite, pinkish-gray (5*YR* 8/1) and and greenish-gray (5*Y* 6/1), fine- to medium-grained, very thin to thin-bedded; some small-scale cross-strata; most prominent quartzite layer occurs from 56 to 80 ft above base of unit; other quartzite layers are generally 1 inch to 2 ft thick. Unit weathers to form slope — 120
18. Quartzite, light-gray (*N*7); rare pale-red (5*R* 6/2) in top one-fourth; fine- to medium-grained; minor medium- to coarse-grained parts; a few thin conglomerate layers with granules and small pebbles (as long as 0.3 in.) of quartz and quartzite(?); very thin to thin bedded and thin tabular planar sets of cross-strata; weathers to form cliff — 218
17. Quartzite (50 percent) and phyllite (50 percent). Quartzite, light-greenish-gray (5*GY* 8/1) to greenish-gray (5*GY* 6/1), mostly fine- to medium-grained; rare medium- to coarse-grained parts (a few layers contain granules); thin bedded; rare low-angle cross-strata. Phyllite, greenish-gray (5*GY* 6/1) to light-gray (*N*7); finely crystalline mica. Quartzite and phyllite occur interstratified in layers 1–25 ft thick. Unit weathers to form slope. Locally along outcrop some pale-red layers (probably phyllite) occur in lower one-third of unit. A 1-ft brown-weathering dolomite occurs from 4 to 5 ft above base of unit — 143
16. Quartzite, yellowish-gray (5*GY* 8/1), very rare greenish-gray (5*GY* 6/1), fine- to medium-grained; some medium- to coarse-grained parts (some conglomeratic layers

Locality 10—Continued

Indian Pass section, measured in Funeral Mountains about ½–2 miles west of Indian Pass. Units 1–14 measured starting in southeastern part of sec. 25, T. 29 N., R. 1 E., and ending in north-central part of sec. 31 (unsurveyed), T. 29 N., R. 2 E. Units 15–25 measured in east-central part of sec. 30 (unsurveyed) and west-central part of sec. 29 (unsurveyed), T. 29 N., R. 2 E.—Con.

Stirling Quartzite (incomplete)—Continued

A member (incomplete)—Continued

	Feet
16. Quartzite, yellowish-gray etc.—Continued in top half of unit contain granules of white quartz); thin bedded; common very thin to thick tabular planar sets of cross-strata; weathers to form cliff. Unit contains a few thin greenish-gray (5*GY* 6/1) phyllite layers in top half	140
Total of incomplete A member	1, 205
Total of incomplete Stirling Quartzite	1, 205

Johnnie Formation:

	Feet
15. Quartzite (60 percent) and phyllite (40 percent). Quartzite, yellowish-gray (5*GY* 8/1), very pale orange (10*YR* 8/2), and greenish-gray (5*GY* 6/1); some fine-grained parts; some medium- to coarse-grained parts (rare conglomeratic layers in lower 20 ft contain granules and small pebbles of white quartz); mostly thin-bedded; some layers 15 ft thick; rare low-angle cross-strata. Phyllite, greenish-gray (5*GY* 6/1) and light-olive-gray (5*Y* 6/1); occurs as 1- 6-ft layers interstratified with quartzite. Unit weathers to form slope	64
Offset in section so that unit 15 measured 3,500 ft northeast of unit 14.	
14. Sandy dolomite and minor dolomite, grayish-orange (10*YR* 7/4) to yellowish-gray (5*Y* 8/1); weather grayish-orange (10*YR* 7/4) and dark yellowish brown (10*YR* 4/2); contain fine to coarse quartz grains that constitute as much as 50 percent of the rock in places; very thin bedded; form prominent orange band	6
13. Quartzite, yellowish-gray (5*Y* 8/1); some light-greenish-gray (5*GY* 8/1) parts; fine to coarse grained, some parts containing scattered granules of quartz; thin bedded; common thin sets of medium-scale cross-strata; weathers to form ledge. Unit remeasured about 1,500 ft northeast; here unit is about 53 ft thick and contains a few thin greenish-gray phyllite layers	50
12. Limy dolomite; similar to unit 9	3
11. Mica schist; similar to unit 5. Several quartzite and granule conglomerate layers occur from 100 to 130 ft above base of unit	280
10. Quartzite and granule conglomerate; yellowish-gray (5*Y* 8/1), olive-gray (5*Y* 4/1) in top half of unit; weather brownish black in top half of unit; grade from fine quartzite to granule conglomerate with clasts of quartz as large as half	

Locality 10—Continued

Indian Pass section, measured in Funeral Mountains about ½–2 miles west of Indian Pass. Units 1–14 measured starting in southeastern part of sec. 25, T. 29 N., R. 1 E., and ending in north-central part of sec. 31 (unsurveyed), T. 29 N., R. 2 E. Units 15–25 measured in east-central part of sec. 30 (unsurveyed) and west-central part of sec. 29 (unsurveyed), T. 29 N., R. 2 E.—Con.

Johnnie Formation—Continued

	Feet
10. Quartzite and granule etc.—Continued an inch in maximum diameter; indistinctly thin bedded; weather to form ledge. A dolomitic sandstone containing granules of quartz occurs from 60 to 61 ft above base of unit. Mica schist occurs from 61 to 66 ft and as a minor part of top 25 ft of unit. Units 8, 9, and 10 apparently pinch out to north, for they cannot be seen on the outcrop half a mile north	120
9. Dolomite, pale-yellowish-brown (10*YR* 6/2); weathers moderate yellowish brown (10*YR* 5/4); finely crystalline; indistinctly thin bedded; forms prominent orange band	3
8. Quartzite, yellowish-gray (5*Y* 8/1), fine-grained to very coarse grained; some scattered granules of quartz; very thin to thin bedded	25
7. Mica schist; similar to unit 5	105
6. Conglomerate and quartzite, yellowish-gray (5*Y* 8/1) and minor olive-gray (5*Y* 4/1); grade from granule conglomerate (some pebbles as large as three-eighths of an inch in maximum diameter) to fine-grained quartzite. Conglomerate mostly in lower half of unit. Unit is indistinctly thin bedded and weathers to form a ledge. Unit apparently pinches out to north, for it cannot be seen on outcrops half a mile north	40
5. Mica schist, light-greenish-gray (5*GY* 8/1) to greenish-gray (5*GY* 6/1); well-defined schistosity; weathers to form steep slope. Unit from 100 to 160 ft below top contains several yellowish-gray fine-grained quartzite layers; some of these quartzite layers coalesce to the northeast within about 100 ft to form a thick layer. Thickness of unit highly uncertain owing to folding and to probability of faults, and to difficulty in determining attitude of stratification. Thickness perhaps in error by 500 ft or more; thickness highly uncertain	1, 600(?)
4. Schist (40 percent), hornfels (30 percent), and quartzite (20 percent). Schist; similar to that in unit 3. Hornfels, medium-dark-gray (*N*4); common finely crystalline muscovite and biotite; well-defined relict lamination. Quartzite, yellowish-gray (5*Y* 8/1) to light-gray (*N*7); fine to very coarse grained; some conglomerate; some fine-grained quartzite is silty; rarely quartzite is limy and weathers light brown. Quartzite occurs in thin beds and conspicuous lenses; lenses commonly are conglomeratic and as thick as 10 ft. Unit weathers to form cliff. Unit gradational into overlying and underlying units	190±

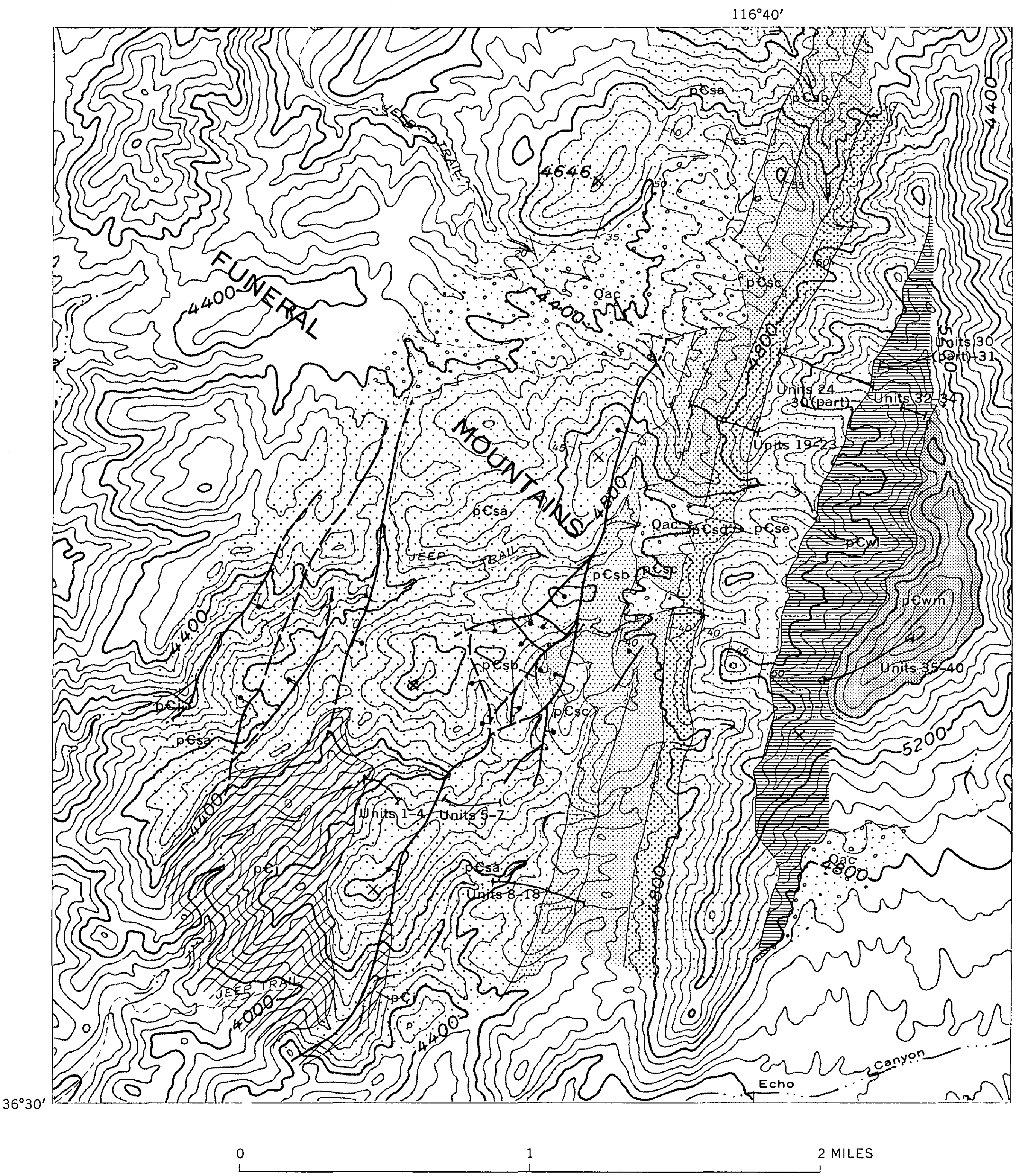


FIGURE 37.—Geologic map of part of Big Dune quadrangle, Nevada-California, showing location of part of Echo Canyon No. 2 stratigraphic section (loc. 11). (See facing page for map explanation.)

Locality 10—Continued

Indian Pass section, measured in Funeral Mountains about ½–2 miles west of Indian Pass. Units 1–14 measured starting in southeastern part of sec. 25, T. 29 N., R. 1 E., and ending in north-central part of sec. 31 (unsurveyed), T. 29 N., R. 2 E. Units 15–25 measured in east-central part of sec. 30 (unsurveyed) and west-central part of sec. 29 (unsurveyed), T. 29 N., R. 2 E.—Con.

	Feet
Johnnie Formation—Continued	
3. Schist, light-greenish-gray (5*GY* 8/1) to greenish-gray (5*GY* 6/1); some light olive gray in top 30 ft; weathers same colors; coarsely crystalline; well-defined schistosity; some garnet porphyroblasts in lower part; weathers to form slope. Unit forms "glistening" outcrop. A few very thin layers of fine-grained quartzite. Schist composed of muscovite, biotite(?), quartz, and feldspar(?)	200±
2. Quartzite and conglomerate, yellowish-gray (5*Y* 8/1) to light-olive-gray, fine-grained to very coarse grained, thin-bedded; weathers to form cliff. Conglomerate contains granules and pebbles (as large as 1.5 in.) of white quartz and quartzite and rare 6-in. cobbles of moderate-yellow-brown-weathering dolomite and mica schist. Top 18 ft contains common schist layers. Schist layers also occur very rarely in rest of unit	308
Total of Johnnie Formation (thickness highly uncertain owing to uncertainty in thickness of unit 5)	2,994(?)
Unnamed unit:	
1. Mica schist, olive-gray (5*Y* 4/1), coarsely crystalline; well-defined schistosity	Unmeasured

Locality 11

Echo Canyon No. 2 section, measured in Funeral Mountains about 1–2½ miles north of Echo Canyon, and generally 3–5 miles east of Echo Mountain, secs. 28, 29, 31, 32, and 33, all unsurveyed, T. 28 N., R. 3 E., and sec. 5 (unsurveyed), T. 27 N., R. 3 E. (see fig. 37 for exact locations of individual segments of section)

[Measured by J. H. Stewart and J. F. McAllister, March and December 1963]

Feet

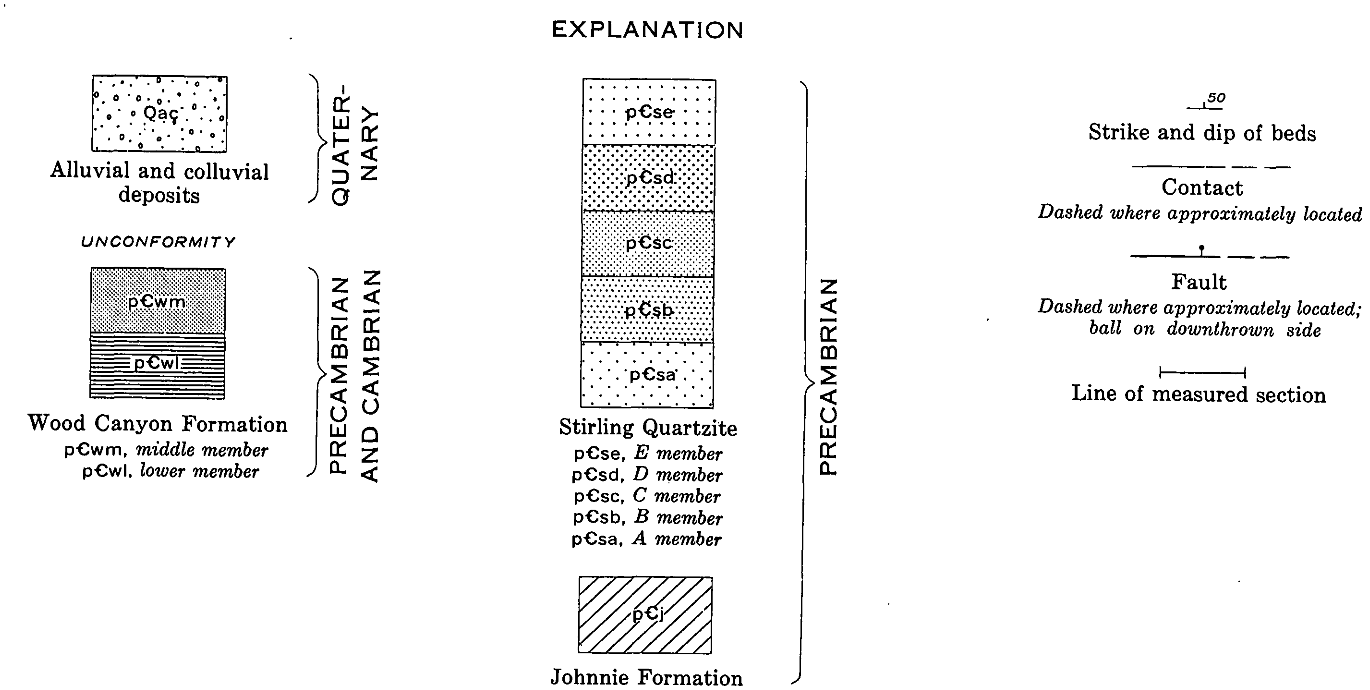
Top of section; top of good exposure.

Wood Canyon Formation (incomplete):

NOTE.—In a section measured by J. F. McAllister and J. H. Stewart in and near sec. 1 (unsurveyed), T. 27 N., R. 2 E., on the south side of Echo Canyon, the part of the Wood Canyon Formation overlying unit 39 is 2,030 ft. thick. The total thickness of the Wood Canyon Formation in the Echo Canyon area is 3,950 ft. (1,920 ft. for units 29–39 and 2,030 ft. for the remainder of the formation). Of this total thickness, 1,274 ft. is assigned to the lower member, 1,661 ft. to the middle member, and 1,015 ft. to the upper member.

Middle member (incomplete):

40. Quartzite to sandstone (70 percent) and siltstone (30 percent). Quartzite to sandstone, pale-red (5*R* 6/2) to pale-red-purple (5*RP* 6/2), and rare yellowish-gray (5*Y* 8/1); weather same colors and grayish red (5*R* 4/2); mostly fine to medium grained; some coarse-grained to very coarse grained parts; mostly very thin trough sets of low-angle small-scale cross-strata; some laminated to thin-bedded parts. Siltstone, grayish-purple (5*P* 4/2); weathers same color; coarse silt;



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Locality 11—Continued

Echo Canyon No. 2 section, measured in Funeral Mountains about 1–2½ miles north of Echo Canyon, and generally 3–5 miles east of Echo Mountain, secs. 28, 29, 31, 32, and 33, all unsurveyed, T. 28 N., R. 3 E., and sec. 5 (unsurveyed), T. 27 N., R. 3 E. (see fig. 37 for exact locations of individual segments of section).—Con.

Wood Canyon Formation (incomplete)—Continued

Middle member (incomplete)—Continued

	Feet
40. Quartzite to sandstone etc.—Continued grades into silty sandstone; micaceous; platy. Unit contains a prominent white quartzite ledge 70–90 ft. above base. One hundred fifty feet of unit exposed to top of hill, more of unit exposed to east along crest and back side of hill. No top to this unit exposed, and total exposed thickness not measured	150+
39. Quartzite and conglomeratic quartzite (95 percent) and siltstone (5 percent). Quartzite and conglomeratic quartzite, pale-red (5*R* 6/2); weather dark brownish gray (10*YR* 4/2) and grayish red (5*R* 4/2); grade from silty very fine grained sandstone to granule conglomerate; most of rock is fine to coarse grained; about 25 percent of rock is conglomerate or conglomeratic; rock is composed of thin to very thin trough sets and minor amount of tabular planar sets of small-scale low-angle cross-strata. Siltstone, grayish-red-purple (5*RP* 4/2), micaceous, platy; ¼–8-in. layers interstratified with rest of unit. Unit weathers to form prominent cliff	143
38. Quartzite to sandstone (50 percent) and siltstone (50 percent). Quartzite to sandstone, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1), and rare yellowish-gray (5*Y* 8/1); weather same colors; grade from silty very fine grained sandstone to very coarse grained sandstone containing scattered granules; some parts laminated to thin bedded; other parts composed of very thin to thin trough and tabular planar sets of small-scale cross-strata. Quartzite to sandstone occurs as 1-in. to 3-ft sets interstratified with siltstone. Siltstone, dark-greenish-gray (5*GY* 4/1); weathers same color; micaceous platy; 1–4-in. layers	120
37. Conglomerate and quartzite, yellowish-gray (5*Y* 8/1) and minor greenish-gray (5*GY* 6/1); weather yellowish gray (5*Y* 8/1); fine-to medium-grained quartzite to conglomerate containing granules and pebbles as large as 2 in. in maximum diameter (mostly of smoky quartz and quartzite and rarely of jasper); some thin-bedded parts; (some small-scale low-angle cross-strata; weather to form small white-weathering ledge prominent from a distance. A lens of grayish-olive (10*Y* 4/1) siltstone occurs 15–16 ft above base of unit	23

Locality 11—Continued

Echo Canyon No. 2 section, measured in Funeral Mountains about 1–2½ miles north of Echo Canyon, and generally 3–5 miles east of Echo Mountain, secs. 28, 29, 31, 32, and 33, all unsurveyed, T. 28 N., R. 3 E., and sec. 5 (unsurveyed), T. 27 N., R. 3 E. (see fig. 37 for exact locations of individual segments of section).—Con.

Wood Canyon Formation (incomplete)—Continued

Middle member (incomplete)—Continued

	Feet
36. Quartzite to silty sandstone, and siltstone. Quartzite to silty sandstone, light-olive-gray (5*GY* 6/1) to olive-gray (5*Y* 4/1), greenish-gray (5*GY* 6/1), and pale-yellowish-brown (10*YR* 6/2); weather same colors; mostly silty very fine to medium-grained sandstone commonly gradational into sandy coarse siltstone; minor amounts of fine- to medium-grained quartzite; laminated; cross-stratified cross-strata in very thin to thin trough sets; mostly low-angle small-scale cross-strata; in 1-in. to 3-ft thick layers interstratified with siltstone. Siltstone, grayish-olive (10*YR* 4/2) to light-olive-gray (5*Y* 5/2); weathers same colors; fine to coarse silt; grades into silty very fine grained sandstone in places; some laminated parts; platy in some parts; blocky splitting in other parts. Amount of quartzite and siltstone varies approximately as follows: 0–55 ft, 80 percent quartzite and sandstone, 20 percent siltstone; 55–205 ft, 30 percent quartzite and sandstone, 70 percent siltstone; 205–306 ft, 50 percent quartzite and sandstone, 50 percent siltstone	360
Total of incomplete middle member	796

Lower member:

	Feet
35. Siltstone (95 percent) and quartzite (5 percent). Siltstone, grayish-olive (10*Y* 4/2); weathers same color; fine to coarse silt; platy in lower two-thirds, becoming more massive upward, particularly in upper third. Quartzite, pale-yellowish-brown (10*YR* 6/2); weathers same color; very fine grained; evenly laminated; minor amounts of very low angle cross-strata; 6-in. to 1-ft layers interstratified with siltstone. Some grayish-orange (10*YR* 7/4) dolomitic(?) siltstone occurs in lower 22 ft of unit. Unit from 22 to 27 ft is composed of pale-yellowish-brown (10*YR* 6/2) moderate-yellowish-brown (10*YR* 5/4)-weathering sandy (very fine) dolomite	183

Offset in section on top of unit 34 so that overlying units measured starting about 1 mile south-southwest of area where underlying units measured.

	Feet
34. Dolomite, light-medium-gray (*N*6) and minor grayish-orange (10*YR* 8/2); weathers pale yellowish brown (10*YR* 6/2) in lower two-thirds and grayish orange (10*YR* 7/4) in upper third; very finely crystalline; evenly laminated; some very low angle cross-strata; weathers to form light-colored ledge	35

Locality 11—Continued

Echo Canyon No. 2 section, measured in Funeral Mountains about 1–2½ miles north of Echo Canyon, and generally 3–5 miles east of Echo Mountain, secs. 28, 29, 31, 32, and 33, all unsurveyed, T. 28 N., R. 3 E., and sec. 5 (unsurveyed), T. 27 N., R. 3 E. (see fig. 37 for exact locations of individual segments of section).— Con.

Wood Canyon Formation (incomplete)—Continued

Lower member—Continued *Feet*

33. Phyllitic siltstone (90 percent) and quartzite (10 percent). Phyllitic siltstone, olive-gray (5*Y* 4/1), dark-greenish-gray (5*GY* 4/1), dusky-yellow (5*Y* 6/4), and light-olive-gray (5*Y* 5/2) dominantly grayish-purple (5*P* 4/2) in basal 30 ft; weathers same colors; micaceous; coarse-grained silt; platy; irregularly laminated to very thin bedded; indistinct stratification. Quartzite, yellowish-gray (5*Y* 8/1) and minor dark-greenish-gray (5*GY* 4/1), very fine to fine-grained; grades to coarse siltstone in places; laminated, some even and some wavy; minor very low angle cross-laminae; quartzite occurs as ½-in. to 2-ft sets interstratified with the phyllitic siltstone. Unit as a whole weathers to form steep slope 218
32. Dolomite, medium-light-gray (*N*6), pale-yellowish-brown (10*YR* 6/2), and moderate-yellowish-brown (10*YR* 5/4); weathers same colors; very finely crystalline; laminated, some even and some slightly wavy; minor amount of small-scale cross-laminae. Unit weathers to form light-colored ledge. Basal 13 ft of unit forms prominent ledge; rest of unit is poorly exposed and forms a slope. Middle third of unit probably contains some grayish-orange (10*YR* 7/4) platy phyllitic siltstone, although none was found in place 47

Offset in section so that overlying units measured 1,000 ft S. 5° W. of underlying units.

31. Phyllitic siltstone (90 percent) and quartzite (10 percent). Phyllitic siltstone, grayish-olive (10*Y* 4/2) and light-olive-gray (5*Y* 5/2); minor dusky yellow (5*Y* 6/4) in lower 200 ft; weathers same colors; micaceous; coarse-grained silt; platy cleavage. Quartzite, yellowish-gray (5*Y* 7/2 and 5*Y* 8/1), light-gray (*N*7), pale-yellowish-brown (10*YR* 6/2), and greenish-gray (5*GY* 6/1), very fine to fine-grained; grades to coarse siltstone in places; evenly laminated; some thin sets of very low angle cross-strata; occurs in sets 1 in. to 2 ft thick interstratified with phyllitic siltstone; most of quartzite is in lower 190 ft of unit. Unit as a whole weathers to form steep slope with a few ledges 353
30. Quartzite, siltstone, and dolomite to sandy dolomite. Quartzite, yellowish-gray (5*Y* 8/1), pale-brown (5*YR* 5/2), and light-brownish-gray (5*YR* 6/1); weathers same colors; fine to medium grained; fair to poor sorting; laminated; occurs dominantly in lower half of unit; found locally in sets 1–3 ft thick interstratified with siltstone. Siltstone, light-olive-gray (5*Y* 6/1) to olive-gray 5*Y* 4/1); weathers same colors; fine to coarse silt; micaceous; platy; occurs dominantly in middle of unit interstratified with quartzite and dolomite. Dolomite to to sandy dolomite, medium-gray (*N*5); weathers moderate yellowish brown (10 *YR* 5/4 to dark yellowish brown (10*YR* 4/2); finely crystalline; commonly contain abundant fine to medium grains (rarely coarse grains) of quartz; laminated; occur from 43 to 48 ft, from 81 to 172 ft (except for a siltstone layer 1 or 2 ft thick), and rarely as very thin to thin beds elsewhere in unit. Unit as a whole weathers to form ridge or series of ledges, prominent along outcrop. Section transferred on horizon within unit so that upper part of unit measured 500 ft north of lower part of unit 172
29. Siltstone (90 percent) and quartzite (10 percent). Siltstone, light-olive-gray (5*Y* 5/2) and dusky-yellow (5*Y* 6/4); weathers same colors; coarse silt; micaceous (possibly phyllitic); platy. Quartzite, yellowish-gray (5*Y* 8/1) and pale-yellowish-brown (10*YR* 6/2); weathers same colors; fine to medium grained; some coarse grains; poor to fair sorting; laminated; some very low angle cross-strata; layers 2 in. to 3 ft thick interstratified with siltstone. Unit weathers to form steep slope 266

Total of lower member 1,274

Total of incomplete Wood Canyon Formation 2,070

Stirling Quartzite:

E member:

28. Quartzite, pinkish-gray (5*YR* 8/1) and pale-red (5*R* 6/2), rarely white (*N*9) and light-greenish gray (5*GY* 8/1) along bedding planes; weathers same colors; medium to coarse grained; fair sorting; composed of very thin to thin beds and very thin to thick sets of cross-strata. Cross-stratification included the following types: (1) very shallow trough sets of low-angle small- to medium-scale cross-strata, (2) very thin to thin tabular planar sets of small- to medium-scale cross-strata, and (3) very shallow

Locality 11—Continued

Echo Canyon No. 2 section, measured in Funeral Mountains about 1–2½ miles north of Echo Canyon, and generally 3–5 miles east of Echo Mountain, secs. 28, 29, 31, 32, and 33, all unsurveyed, T. 28 N., R. 3 E., and sec. 5 (unsurveyed), T. 27 N., R. 3 E. (see fig. 37 for exact locations of individual segments of section).— Continued

Stirling Quartzite—Continued

E member—Continued

	Feet
28. Quartzite, pinkish-gray, etc.—Continued trough sets with very low angle cross-strata about 1–4 ft long. Unit weathers to form pink blocky cliffs	653
27. Quartzite (85 percent) and siltstone to silty sandstone (15 percent). Quartzite, very light gray (*N*8) to yellowish-gray (5*Y* 8/1); weathers same colors; fine to medium grained; fairly well to well sorted; evenly laminated; rare very low angle cross-strata. Siltstone to silty sandstone, dark-yellowish-brown (10*YR* 4/2) to moderate-yellowish-brown (10 *YR* 5/4); weather same colors; range from coarse-grained siltstone to silty very fine to fine-grained sandstone; micaceous; laminated layers 6 in. to 3 ft thick interstratified with quartzite. Unit weathers to form rubble-covered slope; good outcrops in gully 100 ft south of line of sections. Unit contains a few (<1 percent) medium-gray (*N*5) to medium-light-gray (*N*4) dark-yellowish-brown (10*YR* 4/2) weathering dolomitic(?) quartzite layers 1–2 ft thick	615
Total of E member	1,268

D member:

	Feet
26. Quartzite (65 percent), siltstone (30 percent), and dolomite to sandy dolomite (5 percent). Quartzite, very pale orange (10 *YR* 8/2) to pale-yellowish-brown (10*YR* 6/2), and yellowish-gray (5*Y* 8/1); weathers same colors and dark yellowish brown (10*YR* 4/2); fine to medium grained, fairly well to well sorted; evenly laminated; some very low angle cross-strata; layers 1 in. to 3 ft thick interstratified with siltstone. Siltstone, greenish-gray (5*GY* 6/1) to light-olive-gray (5*Y* 6/1); weathers same colors and yellowish gray (5*Y* 8/1); fine to coarse silt; platy. Dolomite to sandy dolomite, yellowish-gray (5*Y* 8/1) to medium-light-gray (*N*6); weathers light brown (5*YR* 6/4); very finely to finely crystalline; abundant fine to medium subrounded quartz grains in most parts; evenly laminated; minor amounts of very low angle cross-strata. Dolomite occurs from 27 to 41 ft, 75 to 76 ft, and 129.5 to 132.0 ft above base of unit. Dolomite from 27 to 41 ft contains some siltstone layers. Dolomite at top of unit is medium gray (*N*5), weathers olive gray (5*Y* 4/1), and contains a 1.3-ft siltstone layer in middle. Unit weathers to form steep slope. Top 15 ft of unit contains mostly medium-gray (*N*5) evenly laminated dolomitic(?) quartzite that weathers light brown (5*YR* 6/4). The dolomite from 27 to 41 ft contains a layer (<1 ft thick) of intraformational conglomerate	132
25. Sandy dolomite, pale-yellowish-brown (10*YR* 6/2); weathers light brown (5*YR* 6/4); fine to medium quartz grains set in very finely crystalline matrix; laminated to thin bedded; rare very low angle cross-strata; weathers to form small ledge. A 6-in. lens of intraformational conglomerate containing fragments of dolomite as large as 0.6 ft is 2 ft below top of unit	8
24. Quartzite (60 percent) and coarse siltstone (40 percent). Quartzite, very pale orange (10*YR* 8/2) to pale-yellowish-brown (10*YR* 6/2) and yellowish-gray (5*Y* 8/1); weathers same colors and dark yellowish brown (10*YR* 4/2); fine to medium grained; fair sorting; some coarse-grained layers; laminated (some parts evenly laminated); some very low angle cross-strata. Coarse siltstone, grayish-orange (10*YR* 7/4) to light-brown (5*YR* 6/4); weathers same colors; platy. Quartzite is in layers 1 in. to 4 ft thick interstratified with the coarse siltstone. Unit as a whole weathers to form steep slope. Unit from 4 to 12 ft is composed of very pale orange (10*YR* 8/2) to light-brown (5*YR* 4/2) limy and dolomitic(?) sandstone; sandstone is medium grained, laminated, contains some very low angle cross-strata, and weathers to form a conspicuous dark ledge	55

Offset in section so that unit 24 and higher units measured about 1,000 ft N. 28° E. of unit 23 and lower units.

23. Dolomite and limestone, medium-light-gray (*N*6) to light-gray (*N*7); dark yellowish orange (10*YR* 6/6) in basal 5 ft and pale yellowish brown (10*YR* 6/2) and light brown (5*YR* 6/4) in top 64 ft; weather yellowish gray (5*Y* 7/2) in most places, but light brown (5*YR* 6/4) in basal 4 ft and top 64 ft; aphanitic to very finely crystalline; laminated to thin bedded; some low-angle cross-laminae, particularly in top 64 ft. Top 64 ft of unit includes common amounts of limestone that contains abundant fine to medium rounded quartz grains. Unit as a whole weathers to form prominent light-colored cliff. Unit from 58 to 71 ft is composed of light-brown (5YR 6/4)

Locality 11—Continued

Echo Canyon No. 2 section, measured in Funeral Mountains about 1–2½ miles north of Echo Canyon, and generally 3–5 miles east of Echo Mountain, secs. 28, 29, 31, 32, and 33, all unsurveyed, T. 28 N., R. 3 E., and sec. 5 (unsurveyed), T. 27 N., R. 3 E. (see fig. 37 for exact locations of individual segments of section).—Continued

Stirling Quartzite—Continued

D member—Continued

	Feet
23. Dolomite and limestone, etc.—Continued and moderate-yellowish-brown (10*YR* 5/4) fine-grained quartzite and phyllitic siltstone. Some minor structural crenulations within unit	256
Total of D member	451

C member:

	Feet
22. Phyllitic siltstone (80 percent) and quartzite (20 percent). Phyllitic siltstone, pale-olive (10*YR* F/2) to grayish-olive (10*Y* 4/2), grayish-green (10*GY* 5/2), and medium-gray (*N*5); weathers same colors with some light brown (5*YR* 6/4); fine to coarse silt; micaceous; platy cleavage at an angle to bedding. Quartzite, light-brown (5*YR* 6/4) and greenish-gray (5*GR* 6/1); weathers same colors; very fine to fine grained; fair sorting; ½–6-in. layers interstratified with phyllitic siltstone. Unit as a whole weathers to form steep slope	336
21. Phyllitic siltstone (60 percent), quartzite (30 percent), and dolomite (10 percent). Phyllitic siltstone, light-greenish-gray (5*GY* 8/1) to greenish-gray (5*GY* 6/1), and grayish-orange (10*YR* 7/4); weathers same colors; micaceous; platy. Quartzite, very pale orange (10*YR* 8/2) to grayish-orange (10*YR* 7/4); weathers same colors; fine grained; fairly well sorted to well sorted; ¼–4-in. layers interstratified with siltstone; some layers are laminated. Dolomite, light-gray (*N*7) to medium-light-gray (*N*6); weathers light brown (5*YR* 6/4); aphanitic; laminated; occurs in 2-in. to 1.5-ft layers interstratified with siltstone and quartzite. Unit as a whole weathers to form steep slope with a few ledges developed on dolomite and quartzite layers	156
20. Quartzite (70 percent) and phyllitic siltstone (30 percent). Quartzite, pinkish-gray (5*YR* 8/1) to light-brownish-gray (5*YR* 6/1); weathers same colors and light brown (5*YR* 6/4); fine to medium grained; some coarse grains; fair sorting. Phyllitic siltstone, greenish-gray (5*GY* 6/1); weathers same color; micaceous. Quartzite and phyllitic siltstone are interstratified in layers ¼-4 in. thick; both are laminated to very thin bedded; laminae and beds are slightly wavy (in places wavy features may be ripples, although no definite ripple marks were noted). Unit as a whole weathers to form minor ridge. Grades into overlying unit	38

Locality 11—Continued

Echo Canyon No. 2 section, measured in Funeral Mountains about 1–2½ miles north of Echo Canyon, and generally 3–5 miles east of Echo Mountain, secs. 28, 29, 31, 32, and 33, all unsurveyed, T. 28 N., R. 3 E., and sec. 5 (unsurveyed), T. 27 N., R. 3 E. (see fig. 37 for exact locations of individual segments of section).—Continued

Stirling Quartzite—Continued

C member—Continued

	Feet
19. Heterogeneous unit marked by light-brown (5*YR* 6/4)-weathering dolomite and yellowish-gray quartzite. Dolomite, medium-light-gray (*N*6) to medium-gray (*N*5), yellowish-gray (5*Y* 8/1), and grayish-yellow (5*Y* 8/4); weathers light brown (5*YR* 6/4) to grayish yellow (5*Y* 8/4); very finely crystalline to aphanitic; some very fine to medium sand grains in some parts; thinly laminated; some possible very low angle cross-strata. Quartzite, yellowish-gray (5*Y* 8/1) to white (*N*9); weathers same colors; medium to coarse grained; fair to good sorting; composed of subrounded clear quartz grains; indistinct very thin beds. Unit as a whole weathers to form prominent marker unit. Sequence of rocks in units is as follows, from base to top: 0.0–0.9 ft, light-brown-weathering dolomite; 0.9–1.9 ft, grayish-yellow (5*Y* 8/4) silty to very fine grained sandy micaceous platy dolomite; 1.9–2.6 ft, light-brown-weathering dolomite; 2.6–4.0 ft, quartzite; 4.0–6.0 ft, light-brown-weathering dolomite containing abundant medium to coarse quartz grains in lower part and grading upward into pure dolomite at top	6±
Total of C member	536

Offset in section on top of unit 18 so that overlying units measured 1¾ miles north-northeast of underlying units.

B member:

	Feet
18. Quartzite to siltstone, grayish-red (5*R* 4/2), grayish-purple (5*P* 4/2), and medium-light-gray (*N*6); weather grayish red (5*R* 4/2); coarse siltstone to fine-grained quartzite; laminated to very thin bedded; laminae and beds are slightly wavy, locally suggesting crude ripple laminae; one example of parallel ripple marks noted. Unit from 290 ft to top contains about 25 percent very pale orange (10*YR* 8/2) fine- to medium-grained quartzite that is in 1–6-in. layers that weather very pale orange (10*YR* 8/2), in contrast with the reddish to purplish adjacent strata; amount of this quartzite increases somewhat upward in section. Unit as a whole weathers to form steep ledgy slope	457
17. Siltstone to sandstone (or quartzite), grayish-red (5*R* 4/2) and minor amount light-greenish-gray (5*GY* 8/1); weathers same colors; coarse siltstone to very fine grained sandstone, minor fine-grained sandstone;	

Locality 11—Continued

Echo Canyon No. 2 section, measured in Funeral Mountains about 1–2½ miles north of Echo Canyon, and generally 3–5 miles east of Echo Mountain, secs. 28, 29, 31, 32, and 33, all unsurveyed, T. 28 N., R. 3 E., and sec. 5 (unsurveyed), T. 27 N., R. 3 E. (see fig. 37 for exact locations of individual segments of section).—Continued

Stirling Quartzite—Continued

B member—Continued

	Feet
17. Siltstone to sandstone, etc.—Continued laminated; some very thin beds; some even lamination; some slightly wavy laminae; some very low angle cross-strata; weather to form slope. About 20 percent of unit from 126 to 183 ft is composed of pale-red (5*R* 6/2)- and pale-brown (5*YR* 5/2)-weathering sandy (very fine) dolomite in beds 1–10 in. thick A few pale-yellowish-brown (10*YR* 6/2) and dark-yellowish-brown (10*YR* 4/2) fine-grained quartzite beds occur in lower half of unit	183
Total of B member	640

A member:

	Feet
16. Quartzite, pinkish-gray (5*YR* 8/1) to pale-red (10*R* 6/2); locally greenish-gray (5*GY* 6/1) along bedding planes or partings; pale purple (5*P* 6/2) to grayish purple (5*P* 4/2) in lower 48 ft; medium to coarse grained; rare very coarse grained parts; granules in a few places; indistinct stratification in many places; mainly irregular beds 1–10 in. thick; some laminated parts and some very thin to thin planar(?) sets of very low angle cross-strata; weathers to form light-colored ridge with some blocky and cliffy outcrops. Top 15 ft contains some finer grained grayish-red quartzite and is transitional into overlying unit	304
15. Phyllite; same as unit 11; contains a few 1–3-in. layers of grayish purple (5*P* 4/2) very fine grained silty quartzite layers	21
14. Quartzite, pale-purple (5*P* 6/2) to grayish purple (5*P* 4/2); weathers grayish purple (5*P* 4/2); medium to very coarse grained; rare granules; probably silty; poorly sorted; indistinct beds ½–8 in. thick; weathers to form minor ledge	11
13. Phyllite; same as that in unit 11	19
12. Limestone and dolomite. Limestone, moderate-red (5*R* 5/4), pale-red (5*R* 6/2), and yellowish-gray (5*Y* 8/1) (colors are in bands ⅛–½ in. thick); weathers same colors and light brown (5*YR* 6/4); finely to medium crystalline (crystals weather out on surface giving rock a clastic or oolitic appearance, although no definite oolites were noted); laminated to very thin bedded. Dolomite, pale-red (5*R* 6/2), grayish-red (5*R* 4/2), and grayish-orange-pink (5*YR* 7/2); weathers pale yellowish brown (10*YR* 6/2); finely to medium crystalline (crystals weather out on surface	

Locality 11—Continued

Echo Canyon No. 2 section, measured in Funeral Mountains about 1–2½ miles north of Echo Canyon, and generally 3–5 miles east of Echo Mountain, secs. 28, 29, 31, 32, and 33, all unsurveyed, T. 28 N., R. 3 E., and sec. 5 (unsurveyed), T. 27 N., R. 3 E. (see fig. 37 for exact locations of individual segments of section).—Continued

Stirling Quartzite—Continued

A member—Continued

	Feet
12. Limestone and dolomite, etc.—Continued giving rock clastic or oolitic appearance); laminated to very thin bedded; some very low angle cross-strata. Dolomite forms bottom 2 ft and top 10 ft of unit. Unit as a whole weathers to form prominent light-colored ledge	45
11. Phyllite, medium-gray (*N*5) to grayish-purple (5*P* 4/2); weathers same colors; micaceous; probably siltstone originally; weathers to form purplish slope. Top 10 ft composed mainly of silty and micaceous very fine to fine-grained (some medium- to coarse-grained) sandstone in layers 1–3 ft thick. Sandstone in top foot of unit is poorly sorted mixture of silt(?), very fine to very coarse sand grains, and possibly a few granules	75±
10. Quartzite, pale-purple (5*P* 6/2) to grayish-purple (5*P* 4/2); weathers same colors; fine to coarse grained; common conglomeratic layers with very coarse grains and granules; indistinct lamination to very thin beds; weathers to form minor ledge. Unit weathers with units 4 and 5 to form major ridge sequence	31
9. Phyllite and minor amount of quartzite. Phyllite, grayish-purple (5*P* 4/2) to medium-gray (*N*5); weathers same colors; micaceous; platy cleavage. Quartzite, grayish-purple (5*P* 4/2); weathers same color; silty; fine to medium grained; micaceous; laminated to very thin bedded; 1–6-in. layers interstratified with phyllite; becomes more abundant in top half of unit and grades into overlying unit. Unit weathers to form slope	16
8. Quartzite, grayish-purple (5*P* 4/2); weathers same color; medium to coarse grained (commonly ranges from medium to very coarse sand in individual sample); rare (5 percent) conglomeratic parts containing granules and small pebbles as large as ½ in. of milky and red-stained(?) quartz and rarely of red chert(?); fair to poor sorting; laminated to thin bedded, beds indistinct; about half of unit has tabular planar sets 3 in. to 3 ft thick of small- to medium-scale cross-strata; weathers to form ridge. Unit contains two layers of grayish-red (5*P* 4/2) coarse phyllitic siltstone: one from 76 to 78 ft and the other from 130 to 134 ft above base of unit. Unit measured along road where it traverses narrow ledgy canyon	368

Locality 11—Continued

Echo Canyon No. 2 section, measured in Funeral Mountains about 1–2½ miles north of Echo Canyon, and generally 3–5 miles east of Echo Mountain, secs. 28, 29, 31, 32, and 33, all unsurveyed, T. 28 N., R. 3 E., and sec. 5 (unsurveyed), T. 27 N., R. 3 E. (see fig. 37 for exact locations of individual segments of section).—Continued

Stirling Quartzite—Continued

A member—Continued — Feet

Offset in section so that overlying units measured about 1,000 ft south of underlying units.

7. Phyllite, grayish-purple (5*P* 4/2) to medium-gray (*N*5); weathers same colors; micaceous; probably siltstone originally; platy in places; forms "pencil shale" in places; weathers to form steep slope and saddle between quartzite units. Unit measured in faulted area and thickness probably not exact owing to concealed faults and folds. Unit poorly exposed in places. In an exposure 500 ft south, medium- to coarse-grained quartzite beds, 1–6 in. thick, are commonly interstratified with the phyllite in the top 40 ft of the unit — 178
6. Quartzite, pale-purple (5*P* 6/2) to medium-light-gray (*N*6); several poorly defined 10- to 30-ft intervals of yellowish-gray (5*Y* 8/1) quartzite in lower third of unit, weathers same colors; medium grained, coarse grained, or very coarse grained; some layers containing granules and small pebbles of smoky quartz as large as ½ in. in diameter; fair to poor sorting; laminated to thin bedded; common irregular and poorly defined laminae and beds; common 3–12-in. tabular planar sets of small- to medium-scale cross-strata; weathers to form prominent ridge. Unit measured in faulted area and attitudes of beds somewhat variable; these factors make exact thickness of unit uncertain. A 1.5-ft phyllite unit is 42 ft above base of unit — 257
5. Phyllite, medium-gray (*N*5) and rare dark-greenish-gray (5*GY* 4/1); purplish cast throughout much of unit; grayish red (5*R* 4/2) and moderate red (5*R* 5/4) from 208 to 230 ft above base; abundant mica; probably a coarse siltstone originally; platy cleavage at angle to stratification; weathers to form a steep slope: Unit contains a few 1–6-in. very fine grained silty phyllitic sandstone beds. Basal 47 ft of unit covered. Elsewhere in area unit appears to contain interbedded quartzite in basal 20–30 ft and to be gradational into underlying unit. Probably 10 or 15 ft of beds could have been duplicated or deleted in offset at base of unit. Unit is in faulted area and may contain hidden faults or folds — 248

Offset in section so that overlying units measured about 1,000 ft east of underlying units.

Locality 11—Continued

Echo Canyon No. 2 section, measured in Funeral Mountains about 1–2½ miles north of Echo Canyon, and generally 3–5 miles east of Echo Mountain, secs. 28, 29, 31, 32, and 33, all unsurveyed, T. 28 N., R. 3 E., and sec. 5 (unsurveyed), T. 27 N., R. 3 E. (see fig. 37 for exact locations of individual segments of section).—Continued

Stirling Quartzite—Continued

A member—Continued — Feet

4. Quartzite, pinkish-gray (5*YR* 8/1), minor amount white (*N*9), and rare yellowish-gray (5*Y* 8/1); weathers pale yellowish brown (10*YR* 6/2) to dark yellowish brown (10*YR* 4/2); mostly medium and coarse grained, some fine grained; very coarse grained quartzite layers and conglomerate layers throughout unit (conglomerate is generally granule conglomerate, although pebbles as large as 1 in. in diameter are found; granules and pebbles are smoky quartz); generally poor to fair sorting; evenly laminated to very thin bedded; commonly has small- to medium-scale cross-strata in tabular planar sets 1 in. to 2 ft thick; cross-strata constitute most of the top half of unit and are less abundant in the lower half. Unit weathers to form cliff and locally underlies bench — 293

Total of A member — 1,866

Total of Stirling Quartzite — 4,761

Johnnie Formation (incomplete):

3. Phyllitic sandstone; similar to unit 1, except top 10(?) ft altered(?) to light greenish gray (5*GY* 8/1); weathers to form steep rubbly slope; poorly exposed. Contact with overlying unit appears comformable, but locally, at least, this contact marks location of bedding plane faulting — 60
2. Conglomerate-quartzite and quartzite, light-gray (*N*7); weather medium gray (*N*5) to light brownish gray (5*YR* 6/1); coarse to very coarse grained; most of basal two-thirds of unit is conglomerate containing milky quartz granules and pebbles as large as 1 in. in diameter, granule conglomerate dominant; unit composed of indistinct beds 4–10 in. thick; unit weathers to form ledge. Position of this unit varies along outcrop, probably owing to structural contortions; in many places it does not appear to be present — 57
1. Phyllitic sandstone, dark-greenish-gray (5*GY* 4/1); weathers greenish gray (5*GY* 6/1); silty; very fine grained; micaceous; evenly laminated; platy cleavage; weathers to form slope — Unmeasured

Total of incomplete Johnnie Formation — 117

Base of section at wash.

Locality 14

Trail Canyon section, measured in various segments near the junction of the south fork of Trail Canyon and Trail Canyon from about 2 to 3 miles south of Aguereberry Point. Base of section about 1/8 mile east of middle part of eastern boundary of sec. 1, T. 19 S., R. 45 E., and top about 1 1/2 miles northeast of NE. cor. of the same section

[Measured by J. H. Stewart and S. D. Stewart, October 1963]

	Feet
Carrara Formation (incomplete):	
38. Siltstone, greenish-gray (5*GY* 6/1); weathers same color; fine silt; some mica; platy; weathers to form slope. Contains about 20 percent sandstone and silty sandstone in basal 25 ft; this sandstone and silty sandstone is greenish gray (5*GY* 6/1) and dark yellowish brown (10*YR* 4/2), weathers the latter color, and is generally very fine to fine grained, but is fine to medium grained in a bed that forms lower 2 ft of unit; sandstone and silty sandstone occurs in 2-in. to 2-ft layers interstratified with siltstone; amount and grain size of sandstone generally decrease upward in lower 25 ft of unit. Lowest carbonate beds, 1–3 in. thick, are about 75 ft above base of unit	Unmeasured
37. Quartzite, pale-yellowish-brown (10*YR* 6/2) and yellowish-gray (5*Y* 8/1); weathers same colors; very fine grained at base grading to fine to medium grained at top; evenly laminated; some low-angle cross-strata in upper half; weathers to form ledge with light-colored part at top. Grades into underlying unit	33
36. Siltstone (60 percent) and quartzite (40 percent). Siltstone, grayish-olive (10*Y* 4/2) and pale yellowish-brown (10*YR* 6/2); weathers same colors and dark yellowish brown (10*YR* 4/2); fine to coarse silt, grading into silty very fine grained sandstone; micaceous in parts. Quartzite, pale-yellowish-brown (10*YR* 6/2); weathers dark yellowish brown (10*YR* 4/2); very fine grained; micaceous in places; evenly laminated 1-in. to 4-ft layers interstratified with siltstone. Some *Scolithus* tubes in siltstone in lower 10 ft of unit. Unit weathers to form slope. Some fine- to medium-grained sandstone in lower 2 ft	50
Total of incomplete Carrara Formation	83
Zabriskie Quartzite:	
35. Quartzite, pinkish-gray (5*YR* 8/1) and yellowish-gray (5*Y* 8/1); weathers same colors and very pale orange (10*YR* 8/2); fine to medium grained; scattered coarse grains; laminated; common irregular and slightly wavy laminae; rare very low angle cross-laminae; obscurely stratified in much of unit, perhaps owing to alteration and crushing of rock; weathers to form prominent light-colored cliff	334
34. Quartzite, yellowish-gray (5*Y* 8/1) and medium-light-gray (*N*6); weathers same colors and dark yellowish brown (10*YR* 4/2); fine to medium grained; scattered coarse grains; laminated; somewhat irregular and wavy laminae;	

Locality 14—Continued

Trail Canyon section, measured in various segments near the junction of the south fork of Trail Canyon and Trail Canyon from about 2 to 3 miles south of Aguereberry Point. Base of section about 1/8 mile east of middle part of eastern boundary of sec. 1, T. 19 S., R. 45 E., and top about 1 1/2 miles northeast of NE. cor. of the same section—Continued

	Feet
Zabriskie Quartzite—Continued	
34. Quartzite, yellowish-gray, etc.—Continued some very low angle small-scale cross-laminae; weathers to form lower dark part of cliff formed on Zabriskie Quartzite; locally forms slope below cliff. A few very thin layers of grayish-olive siltstone occur in lower half of unit. *Scolithus* tubes are common in quartzite in lower 20–30 ft	77
Total of Zabriskie Quartzite	411
Wood Canyon Formation:	
Upper member:	
33. Siltstone (50 percent) and quartzite (50 percent). Siltstone, grayish-olive (10*YR* 4/2), dark-greenish-gray, (5*GY* 4/1) and rare moderate-yellowish-brown (10*YR* 5/4); weathers same colors; fine to coarse silt; commonly micaceous; commonly platy. Quartzite, pale-yellowish-brown (10*YR* 6/2), yellowish-gray (5*Y* 8/1), and light-greenish-gray (5*GY* 8/1); weathers same colors; very fine grained; evenly laminated layers 1 in. to 3 ft thick interstratified with siltstone. A few very thin beds of brown-weathering dolomite occurs in lower 55 ft of unit. *Scolithus* tubes abundant in much of siltstone. Unit weathers to form slope	150
32. Siltstone (35 percent), quartzite (35 percent), and dolomite (30 percent). Siltstone and quartzite; similar to those in underlying unit; some small-scale cross-strata in quartzite in places. Dolomite, pale-yellowish-brown (10*YR* 6/2) and medium-gray (*N*5); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline; oolitic in a few layers; evenly laminated to thin bedded; grades in places to dolomitic siltstone. Lithologic types are interstratified in layers 1 in. to 4 ft thick. Quartzite increases upward in amount at expense of siltstone. Dolomite most abundant from 143 to 181 ft above base of unit, where it constitutes about 60 percent of strata. Pelmatozoan debris common in dolomite. Unit weathers to form brownish ledgy outcrop	222
Section transferred on top of unit 31 so that overlying units measured about 1,000 ft north.	
31. Siltstone and quartzite. Siltstone, dark-greenish-gray (5*GY* 4/1) and grayish-olive (10*Y* 4/2); weathers same colors; fine to coarse silt; in part micaceous; platy and blocky splitting. Quartzite, pale-yellowish-brown (10*YR* 6/2); weathers same color;	

Locality 14—Continued

Trail Canyon section, measured in various segments near the junction of the south fork of Trail Canyon and Trail Canyon from about 2 to 3 miles south of Aguereberry Point. Base of section about 1/8 mile east of middle part of eastern boundary of sec. 1, T. 19 S., R. 45 E., and top about 1½ miles northeast of NE. cor. of the same section—Continued

Wood Canyon Formation—Continued

Upper member—Continued

	Feet
31. Siltstone and quartzite, etc.—Continued mostly very fine grained, rarely fine grained; well sorted; evenly laminated 1-in. to 4-ft layers interstratified with siltstone; minor small-scale cross-strata from 323 to 382 ft. Amount of quartzite is approximately as follows: 0–117 ft, <5 percent; 117–215 ft, 50 percent; 215–323 ft, 20 percent; 323–382 ft, 80 percent; and 382–442 ft, 40 percent. A 1-ft-thick pale yellowish-brown (10*YR* 6/2) dark-yellowish-brown (10*YR* 4/2)-weathering dolomite occurs from 368 to 369 ft above base of unit. Dolomite contains some pelmatozoan debris. *Scolithus* tubes noted rarely in top 60 ft of unit. Some trilobite fragments in quartzite float, but none were noted in place. Unit weathers to form slope	442
Total of upper member	814

Middle member:

	Feet
30. Quartzite (85 percent) and siltstone (15 percent). Quartzite, yellowish-gray (5*Y* 8/1) to pinkish-gray (5*YR* 8/1); weathers same colors; fine to medium grained; some scattered coarse grains; very thin bedded; some small-scale cross-strata. Siltstone, medium-gray (*N*5); weathers same color; fine to coarse silt; sparse mica; platy; 1–12-in. layers interstratified with quartzite. Unit weathers to form base of slope on east side of wash	65
29. Covered; forms wash. Exposures of this interval to north contain quartzite and siltstone similar to those in unit 30 and top 116 ft of unit 28	364
28. Quartzite and siltstone. Quartzite, medium-light-gray (*N*6); weathers dusky yellowish brown (10*YR* 2/2); grain size variable (mostly fine to coarse grained; some very coarse grained); mostly composed of 0.3–1-ft-thick tabular planar and shallow trough sets of low- and high-angle small-scale cross-laminae; some laminated to very thin bedded parts. About 5 percent of unit is conglomeratic quartzite or conglomerate with granules and pebbles as large as 13 mm in diameter. Siltstone, medium-gray (*N*5); weathers same color; fine to coarse silt; micaceous; phyllitic; platy; layers ½-in. to 2-ft thick interstratified with the quartzite. Siltstone constitutes only about 2	

Locality 14—Continued

Trail Canyon section, measured in various segments near the junction of the south fork of Trail Canyon and Trail Canyon from about 2 to 3 miles south of Aguereberry Point. Base of section about 1/8 mile east of middle part of eastern boundary of sec. 1, T. 19 S., R. 45 E., and top about 1½ miles northeast of NE. cor. of the same section—Continued

Wood Canyon Formation—Continued

Middle member—Continued

	Feet
28. Quartzite and siltstone, etc.—Continued percent of lower 240 ft of unit and about 20 percent of the unit above that, although the change is not abrupt. Conglomerate and conglomeratic quartzite are mostly in lower 200 ft, although a few very thin layers are higher. Quartzite and siltstone are slightly purple, but not typical purplish color of middle member. Unit forms prominent hogback; most resistant part of unit is the part that contains only a few percent of siltstone; the part that contains a high percentage of siltstone forms back side of hogback	356
27. Quartzite (60 percent) and siltstone (40 percent). Quartzite, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1), and medium-gray (*N*5); weathers same colors; mostly fine to medium grained; some silty very fine grained parts; rare very coarse grained and conglomeratic parts that contain granules and pebbles as large as 3/8 in.; laminated and cross-laminated on small scale; ¼-in. to 7-ft layers interstratified with siltstone. Siltstone, dark-greenish-gray (5*GY* 4/1) to medium-dark-gray (*N*4); weathers same colors; fine to coarse silt; laminated to thin bedded; ½-in. to 2-ft layers interstratified with quartzite. Unit weathers to form slope marked by some light-colored bands. Base of unit arbitrarily placed at lowest cross-laminated sandstone. A prominent light-colored quartzite ledge occurs from 20 to 27 ft above base of unit	163
Total of middle member	948

Lower member:

26. Siltstone and quartzite. Siltstone, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1); weathers same colors; mostly coarse silt, grading to silty very fine grained sandstone in places; mostly fine to medium silt in lower third; laminated to thin bedded; platy in lower third, blocky splitting in rest of unit. Quartzite, pale-yellowish-brown (10*YR* 6/2) to dark-yellowish-brown (10*YR* 4/2); weathers same colors; very fined grained; evenly laminated 1–10-in. layers interstratified with siltstone. Quartzite constitutes about 30 percent of lower third of unit. Unit weathers to form slope	77

Locality 14—Continued

Trail Canyon section, measured in various segments near the junction of the south fork of Trail Canyon and Trail Canyon from about 2 to 3 miles south of Aguereberry Point. Base of section about 1/8 mile east of middle part of eastern boundary of sec. 1, T. 19 S., R. 45 E., and top about 1½ miles northeast of NE. cor. of the same section—Continued

Wood Canyon Formation—Continued

Lower member—Continued — *Feet*

25. Dolomite, medium-light-gray (*N*6) and pale-yellowish-brown (10*YR* 6/2); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline; evenly laminated to very thin bedded; weathers to form ledge. Middle of unit contains a 6-in. sandy dolomite with fine to medium quartz grains. Basal 4 ft of unit is mostly brown-weathering dolomitic siltstone — 17
24. Siltstone (80 percent) and quartzite (20 percent); similar to unit 22. Unit contains at least one thin layer of medium- to coarse-grained quartzite in middle, about 30 percent dolomite in layers 1–10 in. thick in basal 16 ft and a 1-ft dolomite from 42 to 43 ft above base. Unit weathers to form slope — 82
23. Dolomite, medium-gray (*N*5); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline; evenly laminated to very thin bedded; weathers to form brown ledge — 17
22. Siltstone (65 percent) and quartzite (35 percent). Siltstone, dark-greenish-gray (5*GY* 4/1) and olive-gray (5*Y* 4/1); weathers same colors and olive black (5*Y* 2/1); fine silt; some mica; platy. Quartzite, pale-yellowish-brown (10*YR* 6/2) and minor dark-yellowish-brown (10*YR* 4/2); weathers same colors; very fine grained; mica in some parts; evenly laminated; generally in ½–10-in. layers interstratified with siltstone. Unit from 155 to 180 ft is entirely quartzite. Siltstone in top 58 ft is darker green than that in lower part of unit and weathers greenish black (5*GY* 2/1). A few brown-weathering dolomitic(?) siltstone layers occur in basal 25 ft of unit. Unit weathers to form slope. Thickness of unit somewhat uncertain; measured in area of many small faults, and section could cross one or more of these faults. In addition, some thickness of strata could have been lost during transfer from unit 21 — 238±

NOTE.—Units 22, 23, 24, 25, 26 measured in faulted area. Each unit was measured where it is best exposed and apparently least faulted.

Section transferred on top of unit 21 so that overlying units were measured at a point about 1,000 ft southeast of underlying units. In area where unit 22 measured, unit 21 is dominantly siltstone with only minor dolomite and is difficult to separate from underlying unit 20. Unit 21 appears to have a variable amount of dolomite along the outcrop.

Locality 14—Continued

Trail Canyon section, measured in various segments near the junction of the south fork of Trail Canyon and Trail Canyon from about 2 to 3 miles south of Aguereberry Point. Base of section about 1/8 mile east of middle part of eastern boundary of sec. 1, T. 19 S., R. 45 E., and top about 1½ miles northeast of NE. cor. of the same section—Continued

Wood Canyon Formation—Continued

Lower member—Continued — *Feet*

21. Sandy dolomite (70 percent) and siltstone (30 percent). Sandy dolomite, medium-gray (*N*5); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline; contains a few percent to as much as 25 percent very fine sand and some coarse silt; evenly laminated. Siltstone; same as that in underlying unit; occurs in layers 3–8 in. thick interstratified with dolomite. Unit weathers to form ledge — 14
20. Quartzite (70 percent) and siltstone (30 percent). Quartzite, pale-yellowish-brown (10*YR* 6/2) and olive-gray (5*Y* 4/1); weathers same colors; very fine to fine grained; silty and micaceous in places; evenly laminated to thin bedded; some parts platy; some parts blocky. Siltstone, greenish-gray (5*GY* 6/1) to light-olive-gray (5*Y* 6/1); weathers same colors; fine to coarse silt; some mica; platy; occurs as layers 1–10 in. thick and is mostly in lower one-third of unit. Unit as a whole weathers to form slope between ledgy units above and below — 34
19. Sandy dolomite, medium-gray (*N*5); weathers light brown (5*YR* 6/4); very finely crystalline; contains 5–50 percent very fine to coarse quartz grains; evenly laminated; some small-scale cross-strata; weathers to form brown ledge. Contains a few layers of dolomitic sandstone, similar to the sandy dolomite — 34

Total of lower member — 513

Total of Wood Canyon Formation — 2, 275

Stirling Quartzite:

E member:

18. Quartzite; similar to unit 14; a few dark-yellowish-brown-weathering dolomitic quartzite layers. About 25 percent of top half of unit consists of greenish-gray phyllitic siltstone layers ½–1 ft thick. Unit weathers to form white ledge — 35
17. Quartzite (50 percent) and siltstone (50 percent). Quartzite, yellowish-gray (5*Y* 8/1) to dark-yellowish-brown (10*YR* 4/2); weathers same colors; fine to medium grained; some parts micaceous; evenly laminated; platy in parts. Siltstone, greenish-gray (5*GY* 6/1); weathers same color; fine silt; some mica. Siltstone and quartzite

Locality 14—Continued

Trail Canyon section, measured in various segments near the junction of the south fork of Trail Canyon and Trail Canyon from about 2 to 3 miles south of Aguereberry Point. Base of section about 1/8 mile east of middle part of eastern boundary of sec. 1, T. 19 S., R. 45 E., and top about 1 1/2 miles northeast of NE. cor. of the same section—Continued

Stirling Quartzite—Continued

E member—Continued

	Feet
17. Quartzite (50 percent), etc.—Continued interstratified in layers 1–10 in. thick. Unit weathers to form reentrant	8±
16. Quartzite; similar to that in unit 14; some quartzite is light gray (*N*7), and some is slightly dolomitic and weathers dark yellowish brown (10*YR* 4/2). A 2-ft-thick moderate-yellowish-brown siltstone occurs from 17 to 19 ft above base of unit	39
15. Quartzite (80 percent) and siltstone (20 percent). Quartzite; same as in underlying unit; no conglomeratic parts. Siltstone, greenish-gray (5*GY* 6/1) and moderate-yellowish-brown (10*YR* 5/4); weathers same colors; some mica; phyllitic; fine to coarse silt; platy; layers 1 in. to 2 ft thick interstratified with quartzite. Unit weathers to form slope; less resistant than overlying and underlying units. A dark-yellowish-brown-weathering dolomitic quartzite 1 ft thick occurs about 6 ft above base of unit	36
14. Quartzite, yellowish-gray (5*Y* 8/1); weathers same color; fine- to medium-grained parts; medium- to coarse-grained parts; some very coarse grained parts; rare (about 2 percent) conglomeratic parts, with quartz granules and pebbles as large as 13 mm in maximum diameter (conglomerate mostly in top 150 ft of unit); evenly laminated to very thin bedded; common 3–10-in. tabular planar or shallow trough sets of low-angle cross-laminae; weathers to form cliff. Unit badly faulted; line of section probably does not cross large faults, but could cross small faults. Thickness could easily be in error by 50 ft	524±
Total of E member	642±

Section transferred on top of unit 13 so that unit 14 and overlying units were measured at a point about 1,500 ft north-northwest of the place where unit 13 was measured.

D member:

	Feet
13. Quartzite (80 percent) and dolomitic quartzite or sandstone (20 percent). Quartzite, yellowish-gray (5*Y* 8/1); weathers same color and pale yellowish brown (10*YR* 6/2); fine to medium grained; some scattered coarse grains; laminated to very thin bedded; some waviness to bedding; 4–8-in.-thick tabular planar and shallow trough sets of small-scale cross laminae are common. Dolomitic quartzite or sandstone, pale-yellowish-brown (10*YR* 6/4), and minor amounts of medium-gray (*N*5) and dark-yellowish-brown (10*YR* 6/4); weather dark yellowish brown (10*YR* 4/2); same general grain size and stratification as quartzite; contain a variable amount of dolomite (probably from about 30 percent to only a few percent); grade to quartzite; layers 1 in. to 2 ft thick interstratified with quartzite. Unit as a whole weathers to form steep slope. Unit contains light-brownish-gray (5*YR* 6/1) and pale-yellowish-brown (10*YR* 6/4) sandy dolomite from 314 to 315 ft above base of unit. A few medium-gray (*N*5) and light-greenish-gray (5*GY* 8/1) sandy siltstone or silty very fine grained sandstone layers occur in top 50 ft of unit. One dolomitic sandstone about 50 ft below top of unit contains pebbles of white quartz as large as 1/2 in	330
12. Dolomite, yellowish-gray (5*Y* 8/1); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline; sparse fine to coarse quartz grains; evenly laminated to very thin bedded; weathers to form slope. Contains rare (5 percent) very thin beds of light-olive-gray (5*Y* 6/1) fine-grained siltstone. Rare beds of dolomite contain dolomite clasts as large as 6 in. in diameter set in dolomite matrix	19
11. Quartzite, yellowish-gray (5*Y* 8/1) to white (*N*9); weathers same colors; fine to medium grained; evenly laminated; minor thin tabular planar and trough sets of low-angle cross-laminae; weathers to form light-colored ledge. Contains a few siltstone layers 1/4–1 in. thick	18
10. Siltstone, dolomite, and quartzite. Siltstone, greenish-gray (5*GY* 6/1), light-olive-gray (5*Y* 6/1), and medium-gray (*N*5); weathers same colors; fine to medium silt; irregularly platy. Dolomite, pale-yellowish-brown (10*YR* 6/2) to dark-yellowish-brown (10*YR* 4/2); weathers same colors; commonly contains 10–50 percent rounded fine to medium quartz grains; some layers composed of clastic fragments of dolomite as large as 6 in. across set in dolomite matrix; some layers are laminated. Dolomite occurs as an 8-in. layer at base of unit, as a 1.5 ft layer with base 11 ft above base of unit, as an 81-in. layer with base at 23 ft, and rarely as other scattered 1–3-in.	

Locality 14—Continued

Trail Canyon section, measured in various segments near the junction of the south fork of Trail Canyon and Trail Canyon from about 2 to 3 miles south of Aguereberry Point. Base of section about 1/8 mile east of middle part of eastern boundary of sec. 1, T. 19 S., R. 45 E., and top about 1 1/2 miles northeast of NE. cor. of the same section—Continued

Stirling Quartzite—Continued

D member—Continued

	Feet
10. Siltstone, dolomite, etc.—Continued layers. Quartzite, pale-yellowish-brown (10*YR* 6/2) to dark-yellowish-brown (10*YR* 4/2); weathers same colors; fine grained; evenly laminated; occurs in top half of unit. Quartzite increases in amount upward to almost 100 percent at top of unit. Unit grades into overlying unit. Unit as a whole weathers to form a reentrant	39
Total of D member	406

C member:

	Feet
9. Siltstone and quartzite. Siltstone, grayish-red-purple (5*RP* 4/2) to grayish-purple (5*P* 4/2); some greenish-gray (5*GY* 6/1) in lower 30 ft; weathers same colors; fine to medium silt; some very fine grained white mica; laminated; platy. Quartzite, grayish-purple (5*P* 4/2), yellowish-gray (5*Y* 8/1), and rare greenish-gray (5*GY* 6/1); weathers same colors and pale yellowish brown (10*YR* 6/2); very fine grained and medium to coarse grained, generally becoming coarser upward in unit; evenly laminated; some very low-angle cross-strata in top 30 ft of unit; in layers 1 in. to 1 ft thick interstratified with siltstone. Quartzite constitutes about 30 percent of unit and increases slightly in amount upward in unit. Unit as a whole weathers to form steep ledgy slope. Unit contains ripple marks on a few bedding planes	207
8. Siltstone, light-greenish-gray (5*GY* 8/1), greenish-gray (5*GY* 6/1), and yellowish-gray (5*Y* 8/1); weathers same colors and dark yellowish brown (10*YR* 4/2); fine to medium silt; grades rarely into silty very fine grained sandstone; irregularly platy; weathers to form slope. Unit contains 2 or 3 dolomite layers 4–8 in. thick in lower half; dolomite is similar to that in underlying unit	84
7. Siltstone (80 percent) and dolomite (20 percent). Siltstone, greenish-gray (5*GY* 6/1) to light-greenish-gray (5*GY* 8/1), medium-gray (*N*5), and yellowish-gray (5*Y* 8/1); weathers dominantly light brown (5*YR* 6/4); fine to coarse silt, grading to silty very fine grained sandstone in places; platy. Dolomite, medium-dark-gray (*N*4); weathers light brown (5*YR* 6/4); very finely crystalline; evenly laminated to very thin bedded 2–10-in. layers interstratified with siltstone. Unit as a whole weathers to form slope with minor ledges on dolomite beds. Unit forms conspicuous light-brown band between darker strata	37
Total of C member	328

Section transferred on top of unit 6 so that overlying units were measured about half a mile north across canyon from where unit 6 and underlying units were measured.

B member:

	Feet
6. Quartzite, grayish-purple (5*P* 4/2) to pale-red-purple (5*RP* 4/2); weathers same colors and grayish red (5*R* 4/2); very fine grained; commonly contains minor amounts of fine to medium grains; rarely grades to coarse siltstone; evenly and distinctly laminated; sparse ripple marks and mudcrack(?) fillings; weathers to form steep ledgy slope. Top 75 ft of unit contains about 10 percent yellowish-gray (5*Y* 8/1) fine- to coarse-grained quartzite in layers 1 in. to 1 ft thick. This quartzite is generally laminated to very thin bedded, although a few layers contain small-scale cross-strata	200
Total of B member	200

NOTE.—Top 45 ft of unit 5 may also belong in B member.

A member:

5. Quartzite; yellowish-gray (5*Y* 8/1) in lower half, minor light greenish gray (5*GY* 8/1) in upper half (light greenish gray becomes more abundant upward), and sparsely pale red (5*R* 6/2) in upper 45 ft giving way gradually to color of overlying unit; weathers dominantly yellowish gray (5*Y* 8/1) and pale yellowish brown (10*YR* 6/2); medium to coarse grained in lower 150 ft, mostly fine grained from 150 to 175 ft, and mostly very fine grained from 175 ft to top of unit; mostly laminated to very thin bedded; some tabular planar sets of small-scale cross-strata in lower 150 ft; weathers to form steep ledgy slope. Unit contains a few 1–10 in. layers of pale-red (5*R* 6/2) dark yellowish brown (10*YR* 4/2)-weathering very fine grained dolomitic(?) sandstone in top 45 ft. A few 1–3 in. layers of very fine to coarse-grained poorly sorted sandstone occur in top 10 ft

Locality 14—Continued

Trail Canyon section, measured in various segments near the junction of the south fork of Trail Canyon and Trail Canyon from about 2 to 3 miles south of Aguereberry Point. Base of section about 1/8 mile east of middle part of eastern boundary of sec. 1, T. 19 S., R. 45 E., and top about 1½ miles northeast of NE. cor. of the same section—Continued

Stirling Quartzite—Continued

A member—Continued

	Feet
5. Quartzite; yellowish-gray, etc.—Continued of unit. Top 45 ft of unit is a gradational sequence into overlying unit	250
4. Quartzite and minor phyllitic siltstone. Quartzite; medium light gray (*N*6), pale red purple (5*RP* 6/2), and greenish gray (5*GY* 6/1) from 0 to 132 ft and greenish gray (5*GY* 6/1), yellowish gray (5*GY* 8/1), and minor amounts of pale red purple (5*RP* 6/2) from 132 to 281 ft; weathers dominantly dark yellowish brown (10*YR* 4/2); dominantly medium to coarse grained; some very coarse grained parts; some conglomeratic parts (2–3 percent of unit) with white quartz pebbles as large as 10 mm; indistinct very thin to thin beds; some trough and very thin to thin tabular planar sets of small- to medium-scale cross-laminae. Phyllitic siltstone; same as in underlying unit; several layers in bottom 8 ft of unit; in all the interval from 95 to 98 ft and 120 to 132 ft; in 80 percent of the interval from 224 to 243 ft; and in all the interval from 260 to 266 ft and 279 to 281 ft. Unit as a whole weathers to form dark ledgy slope	281
3. Phyllitic siltstone, medium-gray (*N*5) with blue cast; weathers same color; fine to coarse silt; somewhat micaceous; some indistinct laminations to very thin beds; platy cleavage at angle to bedding; weathers to form prominent gray slope. A yellowish-gray (5*Y* 8/1) quartzite similar to that in underlying unit occurs from 30 to 32 ft above base of unit. A few thin layers of fine- to coarse-grained grayish-purple (5*P* 4/2) quartzite occur in top 10 ft of unit	90±
2. Quartzite, yellowish-gray (5*Y* 8/1) to white (*N*9), and rare pinkish-gray (5*YR* 8/1); weathers very pale orange (10*YR* 8/2) to light brown (5*YR* 6/4); fine to coarse grained; a few very coarse grained and conglomeratic parts in lower half of unit with white quartz pebbles as large as 15 mm in maximum diameter; very thin to thin bedded; about half of unit composed of thin to very thin tabular planar sets of small-scale cross-laminae; weathers to form prominent cliff. Top 35 ft of unit contains a few very thin layers of greenish-gray (5*GY* 6/1) micaceous phyllitic siltstone and some greenish-gray quartzite. Base of unit probably a fault, and some faults may occur higher in unit. Thickness probably fairly accurate but could be in error by about 50–100 ft	455±
Total of A member	1,076±
Total of Stirling Quartzite	2,652

Johnnie Formation (incomplete):

1. Phyllitic siltstone, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1); weathers the latter color; fine to medium silt; platy; weathers to form green slopes. About 300 ft is exposed below place where unit 2 was measured; here unit contains two quartzite and conglomerate layers 30–60 ft thick: these layers are light greenish gray (5*GY* 8/1) and pale red (5*R* 6/2) (weathering light brownish gray (5*YR* 6/1)), are fine to very coarse grained, have conglomeratic parts containing granules and pebbles as large as ½ in. in maximum diameter, are indistinctly very thinly to thinly bedded, contain some small scours along bedding planes, possibly (although quite uncertainly) contain graded beds in places, and weather to form ledges. Unit somewhat contorted by structural movement, and position of conglomerate and quartzite layers is different from place to place along outcrop, suggesting faulting	Unmeasured

Base of section; base of exposure.

Locality 15

Rogers Peak section, measured on northwest side of Rogers Peak, southeastern part sec. 33, southwestern part sec. 34, T. 19 S., R. 45 E.

[Measured by J. H. Stewart, April 1965]

Johnnie Formation (incomplete):

Undifferentiated members (incomplete):

	Feet
11. Phyllite, medium-dark-gray (*N*4) fine textured, micaceous; platy cleavage; weathers to form slope. This type of phyllite occurs for at least 50 ft stratigraphically above top of unit 10; gives way upward into reddish more coarsely crystalline phyllite or schist. Unit is many hundreds of feet thick. Locally may contain a few 10–20 ft thick lenses of carbonate rock, but position cannot be determined owing to structural complexity of area	Unmeasured
10. Phyllite (60 percent) and silty limestone (40 percent). Phyllite, light-olive-gray (5*Y* 6/1), fine textured; platy cleavage. Silty limestone, medium-gray (*N*5) to light-olive-gray (5*Y*	

Locality 15—Continued

Rogers Peak section, measured on northwest side of Rogers Peak, southeastern part sec. 33, southwestern part sec. 34, T. 19 S., R. 45 E.—Continued

Johnnie Formation (incomplete)—Continued

Undifferentiated members (incomplete)—Continued

	Feet
10. Phyllite (60 percent), etc.—Continued 6/1), finely crystalline; contains some mica; laminated; platy splitting. Unit weathers to form slope	18
9. Limestone, medium-light-gray (*N*6); weathers light gray (*N*7); finely crystalline; laminated; weathers to form slope. A 9-in. layer of medium-gray (*N*5) phyllite occurs about 5 ft below top of unit	16
8. Dolomite, very pale orange (10*YR* 8/2) and rare very light gray (*N*8), finely to medium crystalline; laminated in some places; generally thick bedded; weathers to form cliff. Basal 20 ft contains some limy dolomite	148
Total of incomplete undifferentiated members	182

Quartzite member:

	Feet
7. Heterogeneous unit; poorly exposed in part. Limestone, dolomite, phyllite, and quartzite. Limestone, very light gray (*N*8), finely crystalline; contains tremolite in places; sandy (very fine to medium) in a few places; thin to thick bedded. Dolomite, yellowish-gray (5*Y* 8/1); weathers very pale orange (10*YR* 8/2); finely crystalline; thick bedded. Phyllite, light-greenish-gray (5*Y* 8/1) to yellowish-gray (5*GY* 8/1), very fine textured; laminated. Quartzite, very light gray (*N*7) to yellowish-gray (5*Y* 8/1), mostly medium- to coarse-grained; some very fine to fine-grained parts; thin bedded. Unit weathers to form slope. Sequence in unit is as follows: 0–11 ft, covered; 11–30 ft, limestone, rare sandy limestone; 30–65 ft, covered; 65–73 ft, phyllite; 73–86 ft, dolomite; 86–92 ft, medium- to coarse-grained quartzite; 92–105 ft, covered; 105–107 ft, medium- to coarse-grained quartzite; 107–118 ft, phyllite and minor very fine to coarse-grained quartzite	118
6. Sandy limestone and limestone (75 percent) and quartzite (25 percent). Sandy limestone and limestone, very pale orange (10*YR* 8/2) and yellowish-gray (5*Y* 8/1), medium-crystalline; mostly sandy limestone with 5–50 percent fine to coarse quartz grains; laminated to very thin bedded. One thin oolitic limestone layer noted. Quartzite, very pale orange (10*YR* 8/2) to yellowish-gray (5*Y* 8/1), mostly fine grained; some fine- to medium-grained parts; commonly limy and grades to sandy limestone; evenly laminated to very thin bedded; occurs as 1 in.- to 2 ft-thick layers. Most of quartzite is in interval from 20 to 30 ft above base of unit. Unit weathers to form cliff	36

Locality 15—Continued

Rogers Peak section, measured on northwest side of Rogers Peak, southeastern part sec. 33, southwestern part sec. 34, T. 19 S., R. 45 E.—Continued

Johnnie Formation (incomplete)—Continued

Quartzite member—Continued

Offset in section so that unit 6 measured 200 ft north of unit 5.

	Feet
5. Phyllite, medium-dark-gray (*N*4); light greenish gray (5*GY* 8/1) in top 10 ft; weathers mostly dark brownish gray (10*YR* 4/2); very fine textured; weathers to form slope. Poorly exposed locally; thickness somewhat in doubt because upper contact covered. Probably within 5 ft of true thickness	25±
Total of quartzite member	179

Transitional member (lower part probably includes strata laterally equivalent to Noonday Dolomite):

	Feet
4. Limestone (85 percent), sandy and silty limestone (10 percent) and hornfels (5 percent). Limestone, medium-gray (*N*5) to light-gray (*N*7), medium-crystalline, laminated to very thin bedded. Sandy and silty limestone, medium-gray (*N*5) to light-gray (*N*7); weather mostly pale yellowish brown (10*YR* 6/2); contain silt to very fine sand; occur in ¼–1 in. thick even layers interstratified with limestone. Hornfels, light-gray (*N*7) to medium-gray (*N*5), and very pale orange (10*YR* 8/2); weathers mostly pale yellowish brown (10*YR* 6/2); fine textured; probably metasiltstone; occurs in ¼–1-in. thick layers interstratified with limestone. Unit weathers to form cliff	141
3. Limestone and minor silty limestone, and minor hornfels. Limestone and minor silty limestone, medium-gray (*N*5) and rare very pale orange (10*YR* 8/2), silty parts weathering light brownish gray (5*YR* 6/1); commonly contain white mica; laminated to very thin bedded; stratification distinct and even. Hornfels, medium-gray (*N*5) and rare dusky-yellow (5*Y* 6/4); mostly weathers moderate brown (5*YR* 4/4); fine textured; in rare places grades into silty very fine grained quartzite; evenly laminated. All gradations in lithologic types from metasiltstone to limy siltstone to limestone. Unit weathers to form slope. Parts of unit very poorly exposed or covered. Hornfels occurs in following positions: 0–35 ft, 55–75 ft, and is common in top 8 ft of unit. Hornfels may occur elsewhere in unit but is covered	175
2. Sandy limestone, minor limestone, and hornfels. Sandy limestone, very pale orange (10*YR* 8/2) and medium-gray (*N*5); weathers very pale orange (10*YR* 8/2); finely to coarsely crystalline; common very fine to medium quartz grains; lower 20 ft of unit contains very fine to very coarse grains of quartz and	

Locality 15—Continued

Rogers Peak section, measured on northwest side of Rogers Peak, southeastern part sec. 33, southwestern part sec. 34, T. 19 S., R. 45 E.—Continued

Johnnie Formation (incomplete)—Continued

Transitional member, etc.—Continued

	Feet
2. Sandy limestone, etc.—Continued minor amounts of granules and small pebbles (as large as ¼-in. in diameter) of quartz and possibly quartzite. Sandy limestone is laminated to thin bedded. Limestone; similar to sandy limestone; may constitute about 10–20 percent of unit. Hornfels, medium-gray (*N*5), fine textured; laminated to very thin bedded; micaceous in places; apparently metasiltsone and metasandstone very fine grained and silty. Hornfels occurs in layers in following positions: 20–35 ft, 42–50 ft, and as few thin layers in lower 20 ft of unit. Unit as a whole weathers to form light-colored ledge	85
Total of transitional member (lower part probably includes strata laterally equivalent to Noonday Dolomite)	401
Total of Johnnie Formation (incomplete and probably includes strata near base laterally equivalent to Noonday)	762

NOTE.—Contact of unit 2 and Kingston Peak Formation is sharp and flat. Appears to truncate underlying units with an angular discordance of 1°–3°.

Kingston Peak Formation:

1. Schist, hornfels, and minor calcite marble. Schist and and hornfels, medium-gray (*N*5) to dark-greenish-gray (5*GY* 4/1); grade from fine textured hornfels to mica schist; relict laminations well defined. Calcite marble, medium-gray (*N*5); weathers same and light olive gray (5*Y* 6/1); finely crystalline; some sandy (very fine) and micaceous parts; laminated; occurs in ½-in. to 3-ft layers interstratified with schist and hornfels. This unit is several hundred feet thick and is underlain by a metagraywacke unit several hundred feet thick; metagraywacke is fine grained to medium grained, although locally some granules occur	Unmeasured

Locality 16

Hanaupah Canyon section, measured in Hanaupah Canyon near Hanaupah Spring; units 1–14 measured in southeastern part of sec. 18 (unsurveyed), T. 20 S., R. 46 E., units 15–23 in southeastern part sec. 17 (unsurveyed), T. 20 S., R. 46 E.

[Measured by J. H. Stewart, March 1965]

Stirling Quartzite:

	Feet
23. Quartzite, yellowish-gray (5*Y* 8/1) to very light gray (*N*8), fine- to medium-grained, thin-bedded; weathers to form cliff. Unit several hundred feet thick	Unmeasured

Locality 16—Continued

Hanaupah Canyon section, measured in Hanaupah Canyon near Hanaupah Spring; units 1–14 measured in southeastern part of sec. 18 (unsurveyed), T. 20 S., R. 46 E., units 15–23 in southeastern part sec. 17 (unsurveyed), T. 20 S., R. 46 E.—Continued

Johnnie Formation:

Rainstorm Member:

Siltstone and quartzite unit:

	Feet
22. Sandy limestone to sandy dolomite (75 percent) and quartzite (25 percent). Sandy limestone to sandy dolomite, pale-yellowish-brown (10*YR* 6/2) and pale-red (5*R* 6/2); weather dark yellowish brown (10*YR* 4/2); composed of very fine to coarse grains of subrounded quartz set in limestone or dolomite matrix; laminated to thin bedded; minor low-angle cross-strata. Quartzite, yellowish-gray (5*Y* 8/1) to very light gray (*N*8), fine- to medium-grained; thin-bedded 1–5 ft layers interstratified with sandy limestone to sandy dolomite. Unit as a whole weathers to form ledgy slope. Unit probably grades laterally into dolomite at top of Johnnie Formation about 1 mile north	35±
21. Quartzite, yellowish-gray (5*Y* 8/1) and light-brownish-gray (5*YR* 6/1), very fine to fine-grained; rare fine- to medium-grained parts; thin bedded; possibly some small-scale cross-strata; weathers to form ledgy slope	35±
20. Phyllite, and siltstone to sandstone. Phyllite, medium-gray (*N*5) with purple cast, some greenish-gray (5*GY* 6/1), fairly fine textured; probably siltstone originally; laminated. Siltstone to sandstone, yellowish-gray (5*Y* 8/1), pale-yellowish-brown (10*YR* 6/2), and minor greenish-gray (5*GY* 6/1); grade from coarse siltstone to silty very fine grained sandstone; occur as thin beds and lenticular wispy layers in phyllite; constitute about 25 percent of lower three-fourths of unit and about 90 percent of top one-fourth of unit. Top one-fourth of unit is dominantly pale-yellowish-brown laminated coarse siltstone to silty very fine grained sandstone. Unit weathers to form steep slope. Thickness of unit uncertain because of faulting. Thickness probably correct within about 100 ft	400(?)
19. Intraformational conglomerate, pale-yellowish-brown (10*YR* 6/2) and light-olive-gray (5*Y* 6/1); weathers dark yellowish brown (10*YR* 4/2). Composed of limestone (and rarely, phyllite) clasts 1 in. to about 2 ft in diameter set in limy silt matrix; clasts are mostly flat, are elongated parallel	

Locality 16—Continued

Hanaupah Canyon section, measured in Hanaupah Canyon near Hanaupah Spring; units 1–14 measured in southeastern part of sec. 18 (unsurveyed), T. 20 S., R. 46 E., units 15–23 in southeastern part sec. 17 (unsurveyed), T. 20 S., R. 46 E.—Continued

Johnnie Formation—Continued

Rainstorm Member—Continued

Siltstone and quartzite unit—Continued

	Feet
19. Intraformational conglomerate, etc.—Con. to original stratification, and commonly weather out to form holes in rock. Some internal contortions in unit. Unit as a whole appears to be lenticular. Unit weathers to form ledge	13
18. Phyllite (90 percent) and quartzite (10 percent). Phyllite, medium-dark-gray (*N*4) with purplish cast, and rare greenish-gray (5*GY* 6/1), fairly fine textured; probably siltstone originally; laminated; some ripple marks (both cusp and parallel). Quartzite, yellowish-gray (5*Y* 8/1), very fine grained; grades into coarse siltstone; ⅛–6-in. layers interstratified with phyllite; commonly forms wispy discontinuous layers in phyllite. Unit weathers to form steep slope. Unit contains a few 1–4-in. layers of limestone similar to that in unit 17	160
Total of siltstone and quartzite unit	643±

Carbonate unit:

	Feet
17. Phyllite and limestone. Phyllite, medium-gray (*N*5) with a purplish cast; a few greenish gray (5*GY* 6/1) beds; fairly fine textured; probably siltstone originally; well-defined cleavage parallel to stratification; laminated. Limestone, medium-light-gray (*N*6) with purple or pink cast; some very pale orange (10*YR* 8/2) parts; weathers same colors; most commonly weathers very pale orange (10*YR* 8/2); very finely crystalline; laminated. Unit rarely contains intraformational conglomerate composed of fragments of limestone; conglomerate occurs as 1-in. to 6-ft layers interstratified with phyllite. Unit weathers to form ledgy interval. Amount of limestone in unit is as follows: 0–150 ft, 15 percent; 150–180 ft, 50 percent; 180–225 ft, none; 225–280 ft, 20 percent. An 80-ft sill of diorite(?) intrudes unit 200 ft above base; this sill can be traced at this horizon for about half a mile. Thermal metamorphism associated with the intrusion of the diorite has formed hornfels for about 15–20 ft	

Locality 16—Continued

Hanaupah Canyon section, measured in Hanaupah Canyon near Hanaupah Spring; units 1–14 measured in southeastern part of sec. 18 (unsurveyed), T. 20 S., R. 46 E., units 15–23 in southeastern part sec. 17 (unsurveyed), T. 20 S., R. 46 E.—Continued

Johnnie Formation—Continued

Rainstorm Member—Continued

Carbonate unit—Continued

	Feet
17. Phyllite and limestone, etc.—Con. on either side of the sill. Thickness of unit uncertain owing to presence of sill and minor faults. Thickness of unit does not include thickness of sill	280±
Total of carbonate unit	280±
Total of Rainstorm Member	923±

Upper carbonate-bearing and siltstone members, undifferentiated:

16. Phyllite, with minor quartzite in basal 250± ft. Phyllite, greenish-gray (5GY 6/1) to pale-olive (10*Y* 6/2); top 100 ft is medium light gray (*N*6) with a purplish cast; dominantly very fine textured phyllite with well-defined cleavage parallel to bedding; probably claystone originally; indistinctly laminated. Quartzite, light-greenish-gray (5*GY* 8/1) to greenish-gray (5*GY* 6/1), and minor light-olive-gray (5*Y* 6/1), very fine grained; probably silty in most places; micaceous; laminated to thin-bedded; 1–10-in. layers interstratified with phyllite. Quartzite constitutes about 30 percent of lower 250 ft of unit and decreases in amount upward in this part of unit. Top 400 ft of unit is homogeneous phyllite that glistens in sun. Unit as a whole weathers to form steep slope. Thickness of unit somewhat uncertain owing to small faults. Probably within 100 ft of true thickness	650±
Total of upper carbonate-bearing and siltstone members, undifferentiated	650±

Lower carbonate-bearing member:

15. Phyllite (75 percent) and dolomite (25 percent). Phyllite, greenish-gray (5*GY* 6/1) and light-brownish-gray (5*TR* 6/1); well-defined slaty cleavage parallel to bedding; laminated to very thin bedded. Dolomite, medium-dark-gray (*N*4) and minor pale-yellowish-brown (10*YR* 6/2); weathers dark yellowish orange (10*YR* 6/6); very finely crystalline; laminated to very thin bedded; 1–15-in. layers interstratified with phyllite. Unit as a whole weathers to form slope. A few thin layers of light-olive-gray (5*Y* 6/1) fine-grained quartzite occur in basal half of unit. Basal 8 ft of unit covered	55±

Locality 16—Continued

Hanaupah Canyon section, measured in Hanaupah Canyon near Hanaupah Spring; units 1–14 measured in southeastern part of sec. 18 (unsurveyed), T. 20 S., R. 46 E., units 15–23 in southeastern part sec. 17 (unsurveyed), T. 20 S., R. 46 E.—Continued

	Feet
Johnnie Formation—Continued	
Lower carbonate-bearing member—Continued	
14. Dolomite; similar to that in unit 1; laminated to indistinctly thin bedded. Contains a few thin layers of sandy (very fine) dolomite. Unit weathers to form cliff	110±
13. Limestone, medium-gray (N5), very finely crystalline; laminated to thin bedded; weathers to form ledge. Unit contains a few thin layers of dolomite that weathers yellowish gray (5Y 8/1) and very pale orange (10*YR* 8/2) and sandy dolomite that weathers pale yellowish brown (10*YR* 6/2)	12±
Total of lower carbonate-bearing member	177±
Quartzite member:	
12. Dolomite (40 percent), sandy dolomite (40 percent), argillite (10 percent), and quartzite (10 percent). Dolomite; similar to that in unit 1. Sandy dolomite, medium-dark-gray (*N*4); weathers moderate brown (5*YR* 4/4); composed of very fine to coarse quartz grains set in dolomite matrix; laminated; some low-angle cross-strata. Argillite, medium-gray (N5), fine-textured. Quartzite, yellowish-gray (5*Y* 8/1), fine-grained, laminated. Quartzite and argillite form 1–3-ft layers intersttratified with dolomite and sandy dolomite. The rock types are gradational in many places. Unit weathers to form slope. Thickness of unit uncertain owing to many small faults. One dolomite layer about 90 ft above base of unit contains cherty masses and lenses	130±
11. Quartzite to quartzitic siltstone, yellowish-gray (5*Y* 8/1), medium-light-gray (*N*6), and pale-yellowish-brown (10*YR* 6/2); grade from fine-grained quartzite to quartzitic coarse-grained siltstone; laminated to thin bedded; weather to form reentrant in hillside	25
10. Quartzite, very light gray (*N*8) to yellowish-gray (5*Y* 8/1), fine- to medium-grained; some medium-grained to very coarse grained parts; thin bedded; weathers to form ledge. Contains a few thin gray argillite layers in top half	37
9. Argillite, medium-gray (*N*5), fine-textured; weathers to form reentrant. Contains some fine-grained quartzite layers	8
8. Quartzite, light-gray (*N*7), mostly fine- to medium-grained; some medium-grained to very coarse grained parts; thin bedded; rare low-angle cross-strata; weathers to form ledge. Some parts of units are dolomitic and weather moderate yellowish brown (10*YR* 5/4)	27±
7. Mostly covered; probably argillite mostly. Top 5 ft of unit exposed and consists of medium-dark-gray (*N*4) argillite and minor amounts of moderate-yellowish-brown (10*YR* 5/4) dolomite. Dolomite and argillite are irregularly interstratified and appear to vary in amount laterally. Unit highly contorted and thickness uncertain	20(?)
Total of quartzite member	247±
Transitional member:	
6. Dolomite (60 percent) and argillite (40 percent). Dolomite, medium-dark-gray (*N*4); weathers moderate brown (5*YR* 4/4); very finely crystalline to aphanitic; indistinct thin beds; some algal biscuits about 1–2 in. across. Argillite, dark-gray (*N*3), very fine textured. Dolomite and argillite are interstratified in layers 1–4 ft thick. Unit weathers to form reentrant on hillside	30±
5. Dolomite (70 percent), sandy dolomite (20 percent), argillite (5 percent), and quartzite (5 percent). Dolomite; similar to that in unit 1; some is grayish orange (10*YR* 7/4) and weathers with a similar color. Sandy dolomite, yellowish-gray (5*GY* 8/1); weathers moderate yellowish brown (10*YR* 5/4); contains fine to very coarse grains of quartz; laminated to very thin bedded. Argillite, yellowish-gray (5*Y* 7/2), fine-textured, somewhat phyllitic; occurs in 1-in. to 3-ft layers. Quartzite, yellowish-gray (5*Y* 8/1) to pale-yellowish-brown (10*YR* 6/2), mostly fine- to medium-grained; some medium-grained to very coarse grained parts; laminated to very thin bedded 1-in. to 1-ft layers interstratified with rest of unit. Unit weathers to form cliff. Unit characterized by brown bands developed on the sandy dolomite, argillite, and quartzite. Thickness of unit quite uncertain owing to many small faults, but probably accurate to within 50–75 ft. Some intraformational conglomerate layers composed of flat pieces of dolomite set in dolomitic matrix	275±

Locality 16—Continued

Hanaupah Canyon section, measured in Hanaupah Canyon near Hanaupah Spring; units 1–14 measured in southeastern part of sec. 18 (unsurveyed), T. 20 S., R. 46 E., units 15–23 in southeastern part sec. 17 (unsurveyed), T. 20 S., R. 46 E.—Continued

	Feet
Johnnie Formation—Continued	
Transitional member—Continued	
4. Argillite (70 percent) and quartzite (30 percent). Argillite, pale-olive (10*Y* 6/2) and pale-yellowish-brown (10*YR* 6/2), fine-textured; phyllitic in part. Quartzite, yellowish-gray (5*Y* 7/2), fine- to coarse-grained; thin layers interstratified with phyllite. Unit weathers to form brown band	15
Total of transitional member	320±
Total of Johnnie Formation	2,317±
Noonday Dolomite (incomplete):	
3. Dolomite; same as unit 1	80±
2. Sandy dolomite and minor dolomite. Sandy dolomite, light-gray (*N*7); weathers pale yellowish brown (10*YR* 6/2); composed of very fine to fine quartz grains set in dolomite matrix; laminated to thin bedded. Dolomite; same as in unit 1. Unit weathers to form brown band	8
1. Dolomite, medium-light-gray (*N*6); weathers very light gray (*N*8); very finely crystalline; faint thin to thick bedding; weathers to form slope. About 100 ft exposed where section measured; probably more exposed in main canyon to south. Unit may locally contain some phyllite and sandy dolomite, but this is difficult to prove or disprove because of faulting; unit is, in any case, almost entirely dolomite	Unmeasured
Total of incomplete Noonday Dolomite	88±

Locality 18

Six Spring–Johnson Canyons section: units 1–7 measured on south side of Six Spring Canyon, central part sec. 2 (unsurveyed), T. 22 S., R. 46 E.; units 8–10 measured on north side of Six Spring Canyon, northeastern part of sec. 2 (unsurveyed), T. 22 S., R. 46 E., and southeastern part of sec. 35, T. 21 S., R. 46 E.; units 11–25 measured on north side of Johnson Canyon, northeastern part of sec. 26 and northwestern part sec. 25, T. 21 S., R. 46 E.

[Measured by J. H. Stewart, November 1964]

	Feet
Stirling Quartzite (incomplete):	
24. Quartzite; yellowish gray (5*Y* 8/1) in lower 100± ft and dominantly grayish red (5*R* 4/2) above 100± ft; fine to medium grained; laminated to thin bedded; minor low-angle small-scale cross-strata; weathers to form cliff. Unit several hundred feet thick. Contains conglomerate in some parts. Basal 100± ft forms a conspicuous whitish band along outcrop	Unmeasured

Locality 18—Continued

Six Spring–Johnson Canyons section: units 1–7 measured on south side of Six Spring Canyon, central part sec. 2 (unsurveyed), T. 22 S., R. 46 E.; units 8–10 measured on north side of Six Spring Canyon, northeastern part of sec. 2 (unsurveyed), T. 22 S., R. 46 E., and southeastern part of sec. 35, T. 21 S., R. 46 E.; units 11–25 measured on north side of Johnson Canyon, northeastern part of sec. 26 and northwestern part sec. 25, T. 21 S., R. 46 E.—Continued

	Feet
Stirling Quartzite (incomplete)—Continued	
23. Quartzite, grayish-red (5*R* 4/2), pale-yellowish-brown (10*YR* 6/2), dark-yellowish-brown (10*YR* 4/2), and yellowish-gray (5*Y* 8/1), mostly fine- to medium-grained; rare medium- to coarse-grained parts; some limonite-stained parts that may be dolomitic; laminated minor amounts small-scale low-angle cross-strata; weathers to form slope. Basal 2 ft of unit is grayish-red (5*R* 4/2) medium- to coarse-grained quartzite ledge	26
Total of incomplete Stirling Quartzite	26
Johnnie Formation:	
Rainstorm Member:	
Siltstone and quartzite unit:	
22. Siltstone (70 percent) and quartzite (30 percent). Siltstone, light-greenish-gray (5*GY* 8/1), minor moderate-yellowish-brown (10*YR* 5/4), and minor medium-gray (*N*5) with a purple cast; coarse silt; somewhat micaceous; laminated. Quartzite, light-olive-gray (5*Y* 6/1) to olive-gray (5*Y* 4/1); weathers dark yellowish brown (10*YR* 4/2); very fine grained; laminated ½–10-in. layers interstratified with siltstone; occurs dominantly in lower half of unit. A 1-ft layer of moderate-yellowish-brown (10*YR* 5/4) limonite-stained dolomitic(?) fine- to medium-grained sandstone is found about 10 ft above base of unit	31
21. Coarse siltstone to very fine grained sandstone (85 percent) (similar to that in top 80 ft of unit 20) and dolomite to dolomitic sandstone (15 percent). Dolomite to dolomitic sandstone, moderate - yellowish - brown (10*YR* 5/4) and minor light-olive-gray (5*Y* 6/1); weather former color; very finely crystalline; contain scattered to abundant (>50 percent) very fine to coarse quartz grains; laminated to thin bedded; minor amounts low-angle small-scale cross-strata in 1-ft layer of dolomitic sandstone at top of unit; 0.5–1.5 ft layers interstratified with coarse siltstone. Unit as a whole weathers to form slope	34
20. Siltstone to sandstone, grayish-red (5*R* 4/2); minor light greenish gray (5*GY* 8/1) from 110 to 115 ft and entirely	

Locality 18—Continued

Six Spring–Johnson Canyons section: units 1–7 measured on south side of Six Spring Canyon, central part sec. 2 (unsurveyed), T. 22 S., R. 46 E.; units 8–10 measured on north side of Six Spring Canyon, northeastern part of sec. 2 (unsurveyed), T. 22 S., R. 46 E., and southeastern part of sec. 35, T. 21 S., R. 46 E.; units 11–25 measured on north side of Johnson Canyon, northeastern part of sec. 26 and northwestern part sec. 25, T. 21 S., R. 46 E.—Continued

Johnnie Formation—Continued
Rainstorm Member—Continued
Siltstone and quartzite unit—Continued

	Feet
20. Siltstone to sandstone, etc.—Continued light greenish gray (5*GY* 8/1), light olive gray (5*Y* 6/1), and pale yellowish brown (10*YR* 6/2) from 245 to 325 ft; grade from coarse siltstone to very fine grained sandstone; generally micaceous; laminated; minor ripple laminae; common ripple marks (both cuspate and linear) and drag(?) marks on stratification planes; platy to flaggy splitting; weather to form slope. Unit from 295 to 302 ft contains four thin layers of moderate-yellowish-brown (10*YR* 5/4)-weathering limy siltstone. Sandstone in top 50± ft of unit appears to be more evenly laminated than sandstone in rest of unit	325
Total of siltstone and quartzite unit	390

Carbonate unit:

19. Siltstone to limy siltstone (70 percent) and limestone (30 percent). Siltstone to limy siltstone, grayish-red (5*R* 4/2) to pale-red (5*R* 6/2); siltstone weathers grayish red (5*R* 6/2); limy siltstone weathers dark yellowish brown (10YR 4/2); fine to coarse silt; minor mica; laminated and ripple laminated; ripple marks and drag(?) marks common on stratification planes. Limestone, pale-red (5*R* 6/2) to pinkish-gray (5*YR* 8/1); weathers same color and very pale orange (10*YR* 8/2); very finely crystalline; laminated 1-in. to 10-ft layers interstratified with siltstone to limy siltstone. Unit as a whole weathers to form light-colored ledgy interval	150
18. Dolomite, pale-red (5*R* 6/2); weathers moderate yellowish orange (10*YR* 6/6); very finely crystalline; evenly laminated; weathers to form yellow-orange ledge. Bottom 2 ft contains minor amount of silty dolomite, and top 3 ft contains minor amount of pale-red (5*R* 6/2) limestone	7
Total of carbonate unit	157

Locality 18—Continued

Six Spring–Johnson Canyons section: units 1–7 measured on south side of Six Spring Canyon, central part sec. 2 (unsurveyed), T. 22 S., R. 46 E.; units 8–10 measured on north side of Six Spring Canyon, northeastern part of sec. 2 (unsurveyed), T. 22 S., R. 46 E., and southeastern part of sec. 35, T. 21 S., R. 46 E.; units 11–25 measured on north side of Johnson Canyon, northeastern part of sec. 26 and northwestern part sec. 25, T. 21 S., R. 46 E.—Continued

Johnnie Formation—Continued
Rainstorm Member—Continued

Siltstone unit:	Feet
17. Siltstone, medium-gray (*N*5) with purple cast; fine to coarse silt; some very fine grained sandy parts; micaceous; laminated; possibly ripple laminated in parts; weathers to form slope. Some dolomitic siltstone in top foot	14
16. Oolitic dolomite (Johnnie oolite), very pale orange (10*YR* 8/2); composed of oolites ½–2 mm across; indistinctly very thin bedded; weathers to form indistinct white ledge	4
15. Siltstone, pale-olive (10*Y* 6/2) to grayish-olive (10*Y* 4/2), and minor medium-gray (*N*5) with a purplish cast; fine to coarse silt; commonly micaceous; platy; weathers to form slope	30
Total of siltstone unit	48
Total of Rainstorm Member	595

Upper carbonate-bearing member:

14. Siltstone to sandstone, and sparse dolomite. Siltstone to sandstone, olive-gray (5*Y* 4/1) to light-olive-gray (5*Y* 6/1), pale-yellowish-brown (10*YR* 6/2) to moderate-yellowish-brown (10*YR* 5/4), and greenish-gray (5*GY* 6/1); grades from fine siltstone to very fine grained sandstone, but lithology is mostly sandy (very fine) coarse siltstone; micaceous; laminated; rare very low angle cross-strata. Dolomite, olive-gray (5*Y* 4/1) and moderate-yellowish-brown (10*YR* 5/4); weathers the latter color; very finely crystalline; laminated to thin bedded; found in following positions: 3.0–3.5 ft, 43–44 ft, 45–46 ft, and 52.5–53.0 ft above base of unit. Unit as a whole weathers to form slope. Coarse siltstone and very fine grained sandstone are dolomitic in places and weather dark yellowish brown	53
13. Dolomite, yellowish-gray (5*Y* 8/1) to very pale orange (10*YR* 8/2); medium gray (*N*5) in lower 12 ft; weathers pale yellowish orange (10*YR* 8/6); very finely crystalline; irregularly laminated; minor very low angle small-scale cross-strata; weathers to form ledge. Unit forms higher of two light-colored ledges in section. Basal 12 ft of unit contains a minor amount of pale-yellowish-	

Locality 18—Continued

Six Spring–Johnson Canyons section: units 1–7 measured on south side of Six Spring Canyon, central part sec. 2 (unsurveyed), T. 22 S., R. 46 E.; units 8–10 measured on north side of Six Spring Canyon, northeastern part of sec. 2 (unsurveyed), T. 22 S., R. 46 E., and southeastern part of sec. 35, T. 21 S., R. 46 E.; units 11–25 measured on north side of Johnson Canyon, northeastern part of sec. 26 and northwestern part sec. 25, T. 21 S., R. 46 E.—Continued

Johnnie Formation—Continued

Upper carbonate-bearing member—Continued

	Feet
13. Dolomite, yellowish-gray, etc.—Continued brown (10*YR* 6/2) (dark-yellowish-brown-weathering) very fine grained quartzite, which occurs in 1–6 in. layers. Dolomite in top 10 ft commonly contains scattered medium to very coarse grains and granules of quartz	45
12. Quartzite to silty sandstone, and rare (10 percent) dolomitic sandstone. Quartzite to silty sandstone, pale-yellowish-brown (10*YR* 6/2) and minor greenish-gray (5*GY* 6/1), very fine to fine-grained; some silty parts; very fine grained sandstone (practically a coarse siltstone); mostly micaceous; irregularly laminated; rare very low angle small-scale cross-strata. Dolomitic sandstone, pale-yellowish-brown (10*YR* 6/2); weathers moderate yellowish brown (10*YR* 5/4); very fine grained; laminated; occurs in 0.5–4 ft layers. Dolomitic sandstone is common in top 5 ft of unit and in interval about one-third of way up in unit. Unit weathers to form slope	71
11. Dolomite, yellowish-gray (5*Y* 8/1) to very light gray (*N*8); weathers pale yellowish orange (10*YR* 8/6); aphanitic to very finely crystalline; indistinct laminae to very thin beds; abundant very low angle small-scale cross-strata; weathers to form prominent light-colored ledge. Dolomite is commonly sandy (very fine) in places and commonly contains scattered fine to very coarse quartz grains. Some very thin layers in top 20 ft of unit are apparently oolitic	51
10. Quartzite (60 percent), dolomitic and limy sandstone (20 percent), and dolomite (20 percent). Quartzite, yellowish-gray (5*Y* 8/1), light-greenish-gray (5*GY* 8/1), and minor light-olive-gray (5*Y* 6/1) and pale-yellowish-brown (10*YR* 6/2), very fine to fine-grained, rarely fine- to medium-grained, laminated; a few indistinctly thin bedded parts; a few very low angle cross-strata. Dolomitic and limy sandstone, moderate-yellowish-brown (10*YR* 5/4); weathers same color; very fine grained; laminated 0.5–2-ft layers interstratified with quartzite and dolomite. Dolomite, medium-gray (*N*5) and minor olive-gray (5*Y* 4/1); weathers moderate yellowish brown (10*YR* 5/4); aphanitic to very finely crystalline; commonly contains abundant very fine sand grains; laminated 0.5–2-ft layers interstratified with rest of unit; found mostly in top	

Locality 18—Continued

Six Spring–Johnson Canyons section: units 1–7 measured on south side of Six Spring Canyon, central part sec. 2 (unsurveyed), T. 22 S., R. 46 E.; units 8–10 measured on north side of Six Spring Canyon, northeastern part of sec. 2 (unsurveyed), T. 22 S., R. 46 E., and southeastern part of sec. 35, T. 21 S., R. 46 E.; units 11–25 measured on north side of Johnson Canyon, northeastern part of sec. 26 and northwestern part sec. 25, T. 21 S., R. 46 E.—Continued

Johnnie Formation—Continued

Upper carbonate-bearing member—Continued

	Feet
10. Quartzite (60 percent), etc.—Continued 50 ft of unit, where it constitutes about 40 percent of strata; in other places, it forms only a few scattered thin beds. Unit as a whole weathers to form ledgy slope. Thickness of unit somewhat uncertain owing to possibility of minor faulting at top of unit and perhaps within unit	140±
Total of upper carbonate-bearing member	360±

Offset in section at base of unit 10 so that unit 10 measured 1,000 ft north and across side canyon from unit 9.

Siltstone member:

	Feet
9. Siltstone (90 percent) and sandstone (20 percent). Siltstone, grayish-olive (10*Y* 4/2) to dusky-yellow (5*Y* 6/4), and rare grayish-red (10*R* 4/2) to pale-red (5*R* 6/2); fine to coarse silt; micaceous in parts; platy in parts. Sandstone, yellowish-gray (5*Y* 7/2) to dusky-yellow (5*Y* 6/4); weathers dark yellowish brown (10*YR* 6/2); very fine grained; generally micaceous; laminated 1-in. to 3-ft layers interstratified with siltstone. Unit weathers to form gentle slope. Thickness of unit difficult to measure owing to numerous faults in area and incompetent nature of unit. Thickness of unit could be in error by as much at 50 ft. Thickness given is more likely to be too thick than too thin	265±
8. Sandstone and minor amount (10 percent) sandy siltstone. Sandstone, moderate-yellowish-brown (10*YR* 5/4), grayish-orange (10*YR* 7/4), and pale-yellowish-brown (10*YR* 6/2), very fine to fine-grained; possibly silty in some parts; probably dolomitic in places; micaceous; laminated; minor amount very low angle cross-strata. Sandy siltstone, very light gray (*N*8) with moderate-yellowish-brown (10*YR* 6/2) mottling and bands; coarse silt to very fine sand; micaceous; platy; 1–6-in. layers interstratified with sandstone. Unit weathers to form ledgy outcrop. Unit measured in two places: thickness at first locality is 75 ft, but the unit contains some minor folds; thickness at second place is 80 ft in a fairly unbroken section. Top 30 or 40 ft unit gradational into overlying unit	80
Total of siltstone member	345±

Locality 18—Continued

Six Spring–Johnson Canyons section: units 1–7 measured on south side of Six Spring Canyon, central part sec. 2 (unsurveyed), T. 22 S., R. 46 E.; units 8–10 measured on north side of Six Spring Canyon, northeastern part of sec. 2 (unsurveyed), T. 22 S., R. 46 E., and southeastern part of sec. 35, T. 21 S., R. 46 E.; units 11–25 measured on north side of Johnson Canyon, northeastern part of sec. 26 and northwestern part sec. 25, T. 21 S., R. 46 E.—Continued

	Feet
Johnnie Formation—Continued	
Lower carbonate-bearing member:	
7. Dolomite, medium-gray (*N*5); weathers medium gray (*N*5) in lower 5 ft and pale yellowish brown (10*YR* 6/2) in top 3 ft; very finely crystalline; fetid odor when broken; laminated to thin bedded; weathers to form ledge. Contains a few ½-in. thick lenses of black chert in lower 5 ft. Top 3 ft contains some sandy (very fine to fine) dolomite and possibly some oolitic dolomite	8
Total of lower carbonate-bearing member	8
Quartzite member:	
6. Quartzite (90 percent) and siltstone (10 percent). Quartzite, yellowish-gray (5*Y* 8/1) to pale-yellowish-brown (10*YR* 6/2); weathers mostly dark yellowish brown (10*YR* 4/2); mostly medium to coarse grained, rarely very fine to fine grained; contains a few conglomeratic parts with granules and small pebbles (as large as 15 mm) of quartz and rarely of black chert(?); laminated to thin bedded; sparse very low angle cross-strata. Siltstone, light-greenish-gray (5*GY* 6/1), micaceous, platy; 5-ft layer at base of unit and rare 1–4-in. layers interstratified with quartzite in top 50 ft of unit. Unit contains pale-yellowish-brown (10*YR* 6/2) to dark-yellowish-brown (10*YR* 4/2) dolomitic sandstone from 103 to 104 ft and from 132 to 134 ft above base. Unit as a whole weathers to form ledgy slope	155
Total of quartzite member	155
Transitional member:	
5. Dolomite, medium-gray (*N*5); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline; indistinctly laminated to thin bedded; weathers to form prominent brown ledge. Unit contains abundant small algal biscuits in basal 5 ft and from 3 to 5 ft below top. Indistinct pisolites occur in a 1-ft layer about 6 ft below top of unit	22
4. Quartzite, light-gray (*N*7) to yellowish-gray (5*Y* 8/1), fine- to medium-grained; some coarse-grained to very coarse grained parts; indistinctly laminated to thin bedded; rare small-scale low-angle cross-strata; weathers to form ledge	16

Locality 18—Continued

Six Spring–Johnson Canyons section: units 1–7 measured on south side of Six Spring Canyon, central part sec. 2 (unsurveyed), T. 22 S., R. 46 E.; units 8–10 measured on north side of Six Spring Canyon, northeastern part of sec. 2 (unsurveyed), T. 22 S., R. 46 E., and southeastern part of sec. 35, T. 21 S., R. 46 E.; units 11–25 measured on north side of Johnson Canyon, northeastern part of sec. 26 and northwestern part sec. 25, T. 21 S., R. 46 E.—Continued

	Feet
Johnnie Formation—Continued	
Transitional member—Continued	
3. Siltstone (80 percent) and quartzite (20 percent). Siltstone, greenish-gray (5*GY* 6/1) and dark-yellowish-brown (10*YR* 4/2); medium silt; evenly laminated to thinly laminated; abundant bedding plane features, most are apparently mud-crack fillings, but some may be "worm borings" along bedding. Quartzite, pale-yellowish-brown (10*YR* 6/2) to dark-yellowish-brown (10*YR* 4/2), very fine-grained; laminated 1–10-in. layers interstratified with siltstone. Unit weathers to form slope	20
2. Dolomite to sandy dolomite (90 percent) and quartzite (10 percent). Dolomite to sandy dolomite, medium-gray (*N*5) and minor pale-yellowish-brown (10*YR* 6/2); weathers light gray (*N*7) to very pale orange (10*YR* 8/2); very finely crystalline; laminated; contain minor amounts of very low angle small-scale cross-strata; sandy dolomite contains abundant fine to coarse quartz grains and rarely granules and pebbles as large as 15 mm in diameter; sandy dolomite constitutes about 80 percent of lower 125 ft of unit and 20 percent of remainder of unit. Algal biscuits are fairly common in dolomite in top 120 ft of unit. Quartzite, medium-gray (*N*5), pale-yellowish-brown (10*YR* 6/2), and light-olive-gray (5*Y* 6/1), very fine to fine-grained, some fine- to medium-grained; laminated; 1-in. to 4-ft layers interstratified with dolomite and sandy dolomite; some very low angle small-scale cross-strata. Moderate-yellowish-brown (10*YR* 5/4) fine-textured siltstone occurs from 202 to 203 ft and from 245 to 250 ft above base of unit and probably elsewhere in upper part. Unit is divided into three parts: 0–125 ft, mostly sandy dolomite; 125–147 ft, mostly ledge-forming light-gray-weathering dolomite; 147–273 ft, mostly-grayish-yellow (5*Y* 8/4)-weathering dolomite. Unit as a whole weathers to form slope with ledgy outcrops from 125 to 147 ft. Some mud-crack fillings noted in top 50 ft	273
Total of transitional member	331
Total of Johnnie Formation	1,794
Noonday Dolomite	
1. Dolomite, yellowish-gray (5*Y* 8/1); weathers very pale orange (10*YR* 8/2); coarsely	

Locality 18—Continued

Six Spring–Johnson Canyons section: units 1–7 measured on south side of Six Spring Canyon, central part sec. 2 (unsurveyed), T. 22 S., R. 46 E.; units 8–10 measured on north side of Six Spring Canyon, northeastern part of sec. 2 (unsurveyed), T. 22 S., R. 46 E., and southeastern part of sec. 35, T. 21 S., R. 46 E.; units 11–25 measured on north side of Johnson Canyon, northeastern part of sec. 26 and northwestern part sec. 25, T. 21 S., R. 46 E.—Continued

Noonday Dolomite—Continued *Feet*

1. Dolomite, yellowish-gray, etc.—Continued crystalline; structureless; some indistinct laminae in places; weathers to form cliff. Near top contains some sandy dolomite layers with medium to coarse well-rounded quartz grains. Some breccia near contact with Johnnie Formation; brecciation could be structural or sedimentary, most likely the former. If there is structural movement along contact, it is minor, however, because unit can be traced consistently along outcrop ________________________ Unmeasured

Locality 20

Eagle Mountain section, measured on west side of Eagle Mountain, west central part of sec. 20, T. 24 N., R. 6 E.

[Measured by J. H. Stewart, A. R. Palmer, and G. Rabchevsky, September 1961]

Top of section; not top of outcrop. Top of section is S. 67° E. of prominent bend in paved road and S. 77° E., about ½ mile of base of section.

Bonanza King Formation: *Feet*

24. Limestone, medium-gray (*N*5); a few streaks of light brown (5*YR* 6/4); weathers same colors; aphanitic; indistinct and irregular beds about ½–1 in. thick; somewhat mottled appearance to bedding; weathers to form main cliff on west side of Eagle Mountain. Only bottom 30 ft examined ____________________________ Unmeasured

NOTE.—Units 22 and 23 measured in area of minor faults, and thus their thickness may be slightly in error.

Carrara Formation:

23. Limestone (60 percent) and limy siltstone to silty limestone (40 percent); amount of limestone increases in proportion upward. Limestone, medium-gray (*N*5); minor streaks and mottles of light brown (5*YR* 6/4); weathers same colors; aphanitic to very finely crystalline; irregular and indistinct beds ½–3 in. thick. Limy siltstone to silty limestone, pale-brown (5*YR* 5/2), light-brown (5*YR* 6/4), and grayish-red (10*R* 4/2); weathers light brown (5*YR* 6/4) to grayish orange (10*YR* 7/4); mixture of aphanitic calcite and fine silt; thinly laminated to laminated; extremely even thin laminations in places. Unit forms slope grading up into overlying cliff. Limy siltstone and silty limestone occur mainly in lower half of unit. Limestone occurs as 1–2-ft beds in lower half of unit and as thicker almost continuous beds in upper half. Unit grades imperceptibly into overlying massive limestone. Top contact of unit is placed at

Locality 20—Continued

Eagle Mountain section, measured on west side of Eagle Mountain, west central part of sec. 20, T. 24 N., R. 6 E.—Continued

Carrara Formation—Continued

23. Limestone (60 percent), etc.—Continued *Feet* highest silty layer in section, but it is an arbitrary and gradational contact. Fossil collections: 3684–CO (USGS colln. no.) 8 ft below top of unit; 3683–CO, about 18 ft below top of unit; 3682–CO, about 15 ft above base unit; 3664–CO, lower part of unit 23 about at level of 3682 and 3683________________________ 91
22. Limestone; medium gray (*N*5) in lower 15 ft and very pale orange (10*YR* 8/2) to grayish orange (10*YR* 7/4) with some medium-gray layers and mottles in rest of unit; weathers light gray (*N*7) in lower 15 ft and grayish orange (10*YR* 7/4) in rest of unit; aphanitic; irregular and indistinct beds ½–8 in. thick; rock has mottled appearance; weathers to form prominent cliff that is light colored near the top _______________ 48
21. Limy siltstone to silty limestone, pale-brown (5*YR* 5/2); weather grayish brown (5*YR* 3/2); calcite and fine to coarse silt; common white mica in parts; laminated; some contorted lamination; platy splitting in part; weather to form slight reentrant in cliff. Unit weathers with top half of unit 20 to form brown outcrop. _______ 16
20. Limestone; in lower half, medium gray (*N*5) with light-brown (5*YR* 6/4) mottles, streaks, and very thin beds; in upper half, dominantly mottled light brown (5*YR* 6/4) and medium gray (*N*5); aphanitic; irregular and wavy indistinct beds ½–2 in. thick; weathers to form cliff with gray below and brown above. A foot-thick gray "*Girvanella*" bed occurs about 10 ft below top of unit________________________________ 63
19. Limestone (50 percent) and siltstone to limy siltstone (50 percent). Limestone, medium-gray (*N*5) to pale-yellowish-brown (10*YR* 6/2); weathers same colors; aphanitic; laminated to thin bedded; occurs in 6 in. to 3 ft beds interstratified with siltstone to limy siltstone. Siltstone to limy siltstone, light-brown (5*YR* 6/4) to grayish-orange (10*YR* 7/4); weather same color; fine to coarse silt; limy in many places; grade into limestone; laminated; platy splitting. Unit as a whole weathers to form slope containing a few small ledges. Unit is banded with light-brown and light-gray bands___________ 67
18. Limestone, medium-gray (*N*5) with light-brown (5*YR* 6/4) mottles, streaks, and very thin beds; weathers same colors; very finely crystalline to aphanitic; irregular and wavy beds ½–3 in. thick; weathers to form prominent ledge. Lowest bed of transitional sequence between the Carrara and Bonanza King Formations. No "*Girvanella*" noted. Some poorly exposed parts in upper 20–30 ft may be shaly units in part______________ 77

Offset in section so that unit 18 measured 600± ft S. 15° E. of unit 17.

17. Siltstone and shale (90 percent) and limestone (10 percent). Siltstone and shale, dark-green-

Locality 20—Continued

Eagle Mountain section, measured on west side of Eagle Mountain, west central part of sec. 20, T. 24 N., R. 6 E.—Continued

	Feet
Carrara Formation—Continued	
17. Siltstone and shale, etc.—Continued ish-gray (5*GY* 4/1), grayish-red (10*R* 4/2 and 5*R* 4/2), yellowish-gray (5*Y* 8/1), and light-brown (5*YR* 6/4); weather same colors; coarse silt to clay; micaceous in some parts; laminated to very thin bedded; shaly, platy, and slabby splitting. Limestone, medium-gray (*N*5) and grayish-orange (10*YR* 7/4); weathers same colors; very finely crystalline; irregular and wavy very thin beds; occurs in beds 2 in. to 4 ft thick interbedded with shale and siltstone. Unit weathers to form slope with minor ledges on limestone. A heterogeneous unit with minor varieties of rock types; many rock types intergrade with one another. Grayish-red siltstone and shale mostly in top third of unit	217
16. Limestone (75 percent) and siltstone (25 percent). Limestone, medium-gray (*N*5); minor grayish orange (10*YR* 7/4) mottles, streaks, and very thin irregular beds; weathers same colors; very finely crystalline; irregular and wavy beds ½–6 in. thick; rock has mottled appearance caused by blotchy color pattern and by wavy bedding. Siltstone, light-brown (5*YR* 6/4) to pale-yellowish-brown (10*YR* 6/2); weathers same colors; coarse silt; common white mica; platy splitting. Unit as a whole weathers to form prominent ledgy unit. A few thin beds contain abundant *"Girvanella"*	110
15. Siltstone, dark-greenish-gray (5*GY* 4/1) and light-olive-gray (5*Y* 5/2); weathers same colors and dark yellowish brown (10*YR* 4/2); fine to coarse silt; common white mica; laminated to very thin bedded; platy splitting in part; weathers to form slope with a few minor ledges. Unit contains several 6–8 in. medium-gray (*N*5) to dark-yellowish-gray (5*YR* 4/2) limestone beds that weather to form minor ledges	72
14. Shale, yellowish-gray (5*Y* 7/2) to light-olive-gray (5*Y* 5/2), and grayish-red (5*R* 4/2); greenish in lower third and mixed green and red layers in upper two-thirds; weathers same colors; fine silt and clay; well indurated; shaly splitting; weathers to form slope. Trilobites 8–31 ft above base of unit (3681–CO)	217
13. Shale (80 percent) and limestone (20 percent); same as unit 11	32
12. Limestone; same as unit 10; contains some small *"Girvanella"*	5±
11. Shale (85 percent) and limestone (15 percent). Shale, medium-light-gray (*N*6) to light-olive-gray (5*Y* 6/1); weathers pale yellowish brown (10*YR* 6/2); clay and fine silt; platy and some shaly splitting. Limestone, moderate-yellowish-brown (10*YR* 5/4); weathers same color; very finely crystalline; occurs in ½–3-in. beds interstratified with shale. Some limestone beds contain abundant trilobite hash	63

Locality 20—Continued

Eagle Mountain section, measured on west side of Eagle Mountain, west central part of sec. 20, T. 24 N., R. 6 E.—Continued

	Feet
Carrara Formation—Continued	
10. Limestone, medium-gray (*N*5) with grayish-orange (10*YR* 7/4) mottling; weathers same colors; very finely to medium crystalline; irregular and wavy beds ¼–1 in. thick; weathers to form minor ledge. Abundant ¼ in. *"Girvanella"* and a few scraps of trilobites	8±
Offset in section so that unit 10 measured 400 ft, S. 10° W. of unit 10. Between segments of section is small fault dropping strata down to south.	
9. Shale (80 percent) and limestone to limy sandstone (20 percent). Shale, yellowish-gray (5*Y* 7/2) to light-olive-gray (5*Y* 5/2); weathers same colors; fine silt and clay; shaly splitting; some irregular trails(?) on some surfaces. Limestone to limy sandstone, dark-yellowish-brown (10*YR* 4/2) to dusky-yellowish-brown (10*YR* 2/2); weathers same colors; very finely crystalline to aphanitic calcite mixed with variable amounts of very fine sand (lithology is mostly limestone; some parts of the sandstone appear to be quartzitic); generally well indurated; occur in ¼–6-in.-thick beds interstratified with shale. Many beds of limestone contain abundant trilobite material. Unit as a whole weathers to form slope with minor ledges on limestone beds. Several trilobite collections in unit: 3677–CO, 5 ft above base of unit, 250 ft north of line of section; 3678–CO, 15 ft above base of unit, 250 ft north of line of section; 3679–CO, 90–105 ft above base of unit, along line of section; 3680–CO, 15 ft below top of unit, 400 ft south of line of section	145
Offset in section so that unit 9 measured 250 ft south of unit 8.	
8. Shale, pale-olive (10*Y* 6/2), dark-greenish-gray (5*GY* 4/1), pale-yellowish-brown (10*YR* 6/2), and pale-red (10*R* 6/2); weathers same colors although darker; probably mixture of clay and silt; shaly splitting; weathers to form slope between more resistant units above and below. Olenellid scraps in top 2 ft. A few quartzite beds ½–3 in. thick occur in unit; quartzite is grayish red (10*R* 4/2) to moderate brown (5*YR* 4/4), is very fine grained, and contains some mica	60
7. Quartzite and minor quartzitic sandy coarse siltstone, grayish-red (10*R* 4/2) and (5*R* 4/2), pale-red (5*R* 6/2), and rare pinkish-gray (5*YR* 8/1); weathers same colors; very fine grained; abundant white mica; laminated to very thin bedded; form reddish brown rubbly slope with minor ridge at top	62
6. Sandy siltstone, grayish-orange (10*YR* 7/4) to dark-yellowish-brown (10*YR* 6/2); weathers same colors; very fine sand and coarse silt; platy splitting; forms rubble-covered slope; poorly exposed	20
Total of Carrara Formation	1,373

Locality 20—Continued

Eagle Mountain section, measured on west side of Eagle Mountain, west central part of sec. 20, T. 24 N., R. 6 E.—Continued

	Feet
Zabriskie Quartzite:	
5. Quartzite, pinkish-gray (5*YR* 8/1), fine-grained; some fine- to medium-grained parts and common scattered medium to very coarse grains; fair to poor(?) sorting; cemented completely by silica (rock breaks across grains); well-bedded in beds 1–12 in. thick; many evenly laminated parts; no noticeable cross-strata; forms prominent pink outcrops at base of cliffs. No *Scolithus* noted. Top 50 ft is pinker than underlying part of unit; top 3 ft is yellowish gray and forms light-colored band along outcrop	421
4c. Quartzite, grayish-red (5*R* 4/2) to pale-red (5*R* 6/2) and minor yellowish-gray (5*Y* 8/1) to light-greenish-gray, very fine to fine-grained; common fine- to medium-grained parts; laminated to distinctly thin bedded. A few *Scolithus* tubes in lower part of unit. Unit exposed in gully; grades into overlying unit. Top placed at change from grayish-red (5*R* 8/1) strata to pinkish-gray (5*YR* 8/1) strata. Lower 20 ft of unit may be generally finer grained than rest of unit. Some fine- to medium-grained quartzite occurs in basal foot of unit	135
Total of Zabriskie Quartzite	556
Wood Canyon Formation (incomplete):	
Upper member (incomplete):	
4b. Dolomite to dolomitic sandstone, moderate-yellowish-brown (10*YR* 5/4) to dusky-yellow (5*Y* 6/4). Dolomite, aphanitic to very finely crystalline. Dolomitic sandstone, very fine to fine-grained; some parts contain medium to coarse quartz grains. Unit as a whole is indistinctly very thin bedded. Dolomite occurs as 8-in. layers at top and bottom of unit. Unit exposed in gully	3
4a. Quartzite, pale-red (5*R* 6/2) to pinkish-gray (5*YR* 8/1), and minor yellowish-gray (5*Y* 8/1), very fine to fine-grained, laminated; minor very low angle cross-strata; exposed on pediment. Contains abundant *Scolithus* tubes. A 1-ft-thick layer of grayish-olive (5*Y* 4/2) micaceous coarse siltstone occurs in middle of unit	42
3. Quartzite (95 percent) and dolomitic sandstone (5 percent). Quartzite pinkish-gray (5*YR* 8/1), minor very light gray (*N*8) and pale-yellowish-brown (10*YR* 6/2); some grayish-red (10*R* 4/2) patches; weathers same colors; very fine grained; micaceous in part; well indurated; indistinct very thin to thin beds. Dolomitic sandstone, moderate-red (5*R* 5/4); weathers moderate brown; very fine grained; perhaps 20 percent of rock is dolomite cement. Generally, quartzites occur as distinctive moderate-brown-weathering beds 6–12 in.	

Locality 20—Continued

Eagle Mountain section, measured on west side of Eagle Mountain, west central part of sec. 20, T. 24 N., R. 6 E.—Continued

	Feet
Wood Canyon Formation (incomplete)—Continued	
Upper member (incomplete)—Continued	
3. Quartzite (95 percent), etc.—Continued thick; some contain irregular "worm borings." In all, about 5 ft of unit is dolomitic sandstone	42
2. Quartzite, pinkish-gray (5YR 8/1); some light-greenish-gray (5*GY* 8/1) parts; abundant grayish-red (10*R* 4/2) mottling; some pale-red (10*R* 6/2) parts; weathers same colors; very fine grained; fairly well to well sorted; composed of subround to subangular clear quartz; well indurated; indistinct beds 1–6 in. thick; poorly exposed in part	69
1. Poor outcrops on pediments; some outcropping beds of dolomite and limy dolomite. Dolomite to limy dolomite, pale-reddish-brown (10*R* 5/4); weather dark yellowish-brown (10*YR* 4/2) and light brown (5*YR* 6/4); exhibit various textures from well-defined oolite beds (oolites about 1 mm in diameter) to beds with abundant pelmatozoa plates set in very finely crystalline matrix to beds of aphanitic to very finely crystalline dolomite; occur in 6–12-in. beds; little, if any, bedding within individual beds; exposed on pediment surface. Top 6±-in. bed contains pelmatozoa debris and some small spines, as well as some possible pieces of chert. Total amount of dolomite and limy dolomite that crops out is about 20 ft; more of this outcropping in top third of unit than in the rest of unit	140
Total of incomplete Wood Canyon Formation	296

Base of section; base of exposure. Base of section about ½ mile east of road and about ¾ mile southeast of prominent bend in road.

Locality 21 (section 1)

Northern part of Resting Spring Range No. 1 section, measured in the northern Resting Spring Range about 7 miles east-southeast of Eagle Mountain and about 2 miles west of Stewart triangulation station, southeastern part of sec. 20 and west-central part of sec. 21, T. 24 N., R. 7 E.

[Measured by J. H. Stewart and S. D. Stewart, October 1963]

Stirling Quartzite (incomplete):

A member (incomplete):

10. Quartzite, yellowish-gray (5*Y* 8/1); weathers same color; fine to medium grained; fairly well sorted; indistinct beds 0.5–2 ft thick; some laminated to very thin-bedded parts; about 25–50 percent composed of 0.5–1.5-ft-thick tabular planar sets of small- to medium-scale cross-laminae; weathers to form cliff. Contains some (5 percent) conglomeratic

Locality 21 (section 1)—Continued

Northern part of Resting Spring Range No. 1 section, measured in the northern Resting Spring Range about 7 miles east-southeast Eagle Mountain and about 2 miles west of Stewart triangulation station, southeastern part of sec. 20 and west-central part of sec. 21, T. 24 N., R. 7 E.—Continued

Stirling Quartzite (incomplete)—Continued

A member (incomplete)—Continued

	Feet
10. Quartzite, yellowish-gray, etc.—Continued parts with granules and small pebbles of quartz; largest pebble noted was 31 mm in maximum diameter. Overlain by grayish-purple fine- to medium-grained quartzite, but the overlying unit probably in fault contact with unit 10. Strata in unit are somewhat warped, in a few places but section is believed to be intact and thickness to be fairly accurate	483
Total of incomplete A member	483
Total of incomplete Stirling Quartzite	483

Johnnie Formation (incomplete):

Rainstorm Member:

	Feet
9. Phyllitic siltstone, greenish-gray (5*GY* 6/1) to light-greenish-gray (5*GY* 8/1), and rare light-brownish-gray (5*YR* 6/1); weathers same colors; fine silt; platy splitting; weathers to form steep slope. Unit contains rare (<1 percent) beds ¼–4 in. thick of pale-yellowish-brown (10YR 6/2) laminated very fine grained quartzite. Contact with overlying unit appears conformable, but could be site of some structural movement	293
8. Conglomerate and quartzite, pinkish-gray (5*YR* 8/1) and yellowish-gray (5*Y* 8/1); weather grayish red (5*R* 4/2); grain size variable from fine- to medium-grained quartzite to conglomerate composed of granules and pebbles (maximum pebble size noted is 30 mm in maximum diameter; granules and pebbles of white quartz); weather to form ledge. Quartzite and conglomerate occur in about equal amounts and are interstratified in layers 3 in. to 4 ft thick, some of which are composed of indistinct beds from 1–10 in. thick. Some conglomerate layers contain questionable graded bedding. Thickness of unit somewhat uncertain owing to many small faults	58
7. Phyllitic siltstone, light-olive-gray (5*Y* 6/1) to greenish-gray (5*GY* 6/1); weathers same colors; fine silt; evenly laminated; platy splitting; weathers to form slope. Contains a few (<1 percent) quartzitic siltstone layers ¼–1 in. thick similar to those in underlying unit	475
6. Phyllitic siltstone (60 percent) and quartzite to quartzitic siltstone (40 percent). Phyllitic siltstone, greenish-gray (5*GY* 6/1) to light-olive-gray (5*Y* 6/1); weathers same colors and olive gray (5*Y* 4/1); fine silt; platy splitting.	

Locality 21 (section 1)—Continued

Northern part of Resting Spring Range No. 1 section, measured in the northern Resting Spring Range about 7 miles east-southeast Eagle Mountain and about 2 miles west of Stewart triangulation station, southeastern part of sec. 20 and west-central part of sec. 21, T. 24 N., R. 7 E.—Continued

Johnnie Formation (incomplete)—Continued

Rainstorm Member—Continued

	Feet
6. Phyllitic siltstone, etc.—Continued Quartzite to quartzitic siltstone, pale-yellowish-brown (10*YR* 6/2) and medium-gray (*N*5); weathering dark yellowish brown 10*YR* 4/2); grade from coarse quartzitic siltstone to very fine grained quartzite; evenly laminated; occur in 1-in. to 2-ft layers interstratified with phyllitic siltstone; platy splitting. Unit weathers to form slope. Basal half of unit contains a few layers of dolomitic siltstone and a 1-ft-thick layer of medium gray (*N*5) very finely crystalline limtstone	216
5. Dolomite, pale-yellowish-brown (10*YR* 6/2) to moderate-yellowish-brown (10*YR* 5/4); weathers the latter color; very finely crystalline, almost aphanitic; no oolites seen; faintly thin bedded; weathers to form prominent brown ledge. About 1 mile north, this unit is oolitic; probably is Johnnie oolite	13
4. Phyllitic siltstone; light greenish gray (5*GY* 8/1) in lower part and grayish purple (5*P* 4/2) in upper part; weathers same colors; fine silt; platy splitting; weathers to form slope. Forms prominent light-colored glistening band below prominent brown-weathering dolomite of unit 5	81
Total of Rainstorm Member	1, 136

Undifferentiated members:

	Feet
3. Quartzite, yellowish-gray (5*Y* 8/1) and medium-gray (*N*5); weathers mostly olive gray (5*Y* 4/1) and yellowish gray (5*Y* 8/1); silty; very fine grained; some very fine to fine-grained parts; some indistinct laminae; platy splitting; weathers to form minor ledge	31
2. Phyllitic siltstone, grayish-olive (10*Y* 4/2), light-greenish-gray (5*GY* 8/1), and light-gray (*N*7); weathers same colors; probably fine- to medium-grained siltstone originally; platy splitting; weathers to form slope. A 1-ft-thick dark-yellowish-brown dolomite bed occurs from 90 to 91 ft above base of unit	100
1. Phyllitic siltstone to silty quartzite, medium-gray (*N*5) to medium-light-gray (*N*6); weather dark gray (*N*3); grade from phyllitic siltstone at base to silty very fine grained quartzite in upper 30 ft; some faint bedding in quartzite near top of unit. Unit weathers to form small ledge at top and slope below. Contains several 1-in. to 3-ft layers of dark-yellowish-orange (10*YR* 6/6) evenly laminated very finely crystalline dolomite in lower half. Thickness of unit approximate	

Locality 21 (section 1)—Continued

Northern part of Resting Spring Range No. 1 section, measured in the northern Resting Spring Range about 7 miles east-southeast Eagle Mountain and about 2 miles west of Stewart triangulation station, southeastern part of sec. 20 and west-central part of sec. 21, T. 24 N., R. 7 E.—Continued

	Feet
Johnnie Formation (incomplete)—Continued	
Undifferentiated members—Continued	
1. Phyllitic siltstone, etc.—Continued owing to difficulty in estimating strike and dip	128
Total of undifferentiated members	259
Total of incomplete Johnnie Formation	1, 395

Locality 21 (section 2)

Northern part of Resting Spring Range No. 2 section, measured on western slope of the northern part of the Resting Spring Range about 6 miles east-southeast of Eagle Mountain, east-central part of sec. 18, northern part of sec. 17, and west-central part of sec. 16, T. 24 N., R. 7 E.

[Measured by J. H. Stewart and S. D. Stewart, October 1963]

	Feet
Carrara Formation (incomplete):	
44. Siltstone, olive-gray (5*Y* 4/1); rare grayish-red (5*R* 4/2) alteration along fractures; weathers same colors; fine to medium silt; some mica; platy; weathers to form rubble-covered slope. About 50 ft exposed. Only basal few feet examined	Unmeasured
43. Quartzite, yellowish-gray (5*Y* 8/1) to very light gray (*N*5); weathers same colors; very fine to fine grained; indistinctly very thin bedded; weathers to form white ledge; largely covered	6±
42. Siltstone, dark-yellowish-brown (10*YR* 4/2) and light-olive-gray (5*Y* 5/2); weathers same colors; fine silt in lower half, mostly coarse silt in upper half; platy splitting in lower half, mostly blocky splitting in upper half; some distinctly laminated to thin-bedded parts; weathers to form slope. *Scolithus* tubes abundant in upper half of unit. Unit contains a thin layers of yellowish-gray (5*Y* 8/1) laminated very fine grained quartzite in upper half. Thickness of unit highly uncertain owing to several faults with displacements of 5–10 ft and a considerable amount of cover. Thickness given is a minimum figure	30(?)
Total of incomplete Carrara Formation	36(?)
Zabriskie Quartzite:	
41. Quartzite, pinkish-gray (5*YR* 8/1) and rare grayish-red (5*R* 4/2); yellowish gray (5*Y* 8/1) in top 5 ft; weathers same colors; mostly fine to medium grained; some scattered coarse grains; poor to fair sorting; indistinctly laminated to very thin bedded; slightly inclined and wavy laminae in places; weathers to form prominent hogback. A few faults along top surface with displacements of 5–10 ft, so thickness of unit could be in error by 10–20 ft	330

Locality 21 (section 2)—Continued

Northern part of Resting Spring Range No. 2 section, measured on western slope of the northern part of the Resting Spring Range about 6 miles east-southeast of Eagle Mountain, east-central part of sec. 18, northern part of sec. 17, and west-central part of sec. 16, T. 24 N., R. 7 E.—Continued

	Feet
Zabriskie Quartzite—Continued	
40. Quartzite, grayish-red (5*R* 4/2); weathers same color; fine to medium grained; fair to poor sorting; indistinctly laminated to very thin bedded; some slightly inclined laminae in places; weathers to form prominent red ledge below main cliff of the Zabriskie Quartzite. *Scolithus* tubes abundant in most of unit	30
39. Quartzite (80 percent) and siltstone (20 percent). Quartzite, yellowish-gray (5*Y* 8/1), greenish-gray (5*GY* 6/1), and grayish-orange (10*YR* 7/4); weathers same colors; some very fine or fine-grained parts; common fine- to medium-grained parts (a very thin layer about 10 ft above base of unit contains scattered granules); indistinctly to distinctly laminated to very thin bedded. Siltstone, grayish-olive (10*Y* 4/2) to dusky-yellow (5*Y* 6/4); weathers same colors; fine to coarse silt; commonly micaceous; platy; layers ¼ in. to 3 ft thick interstratified with quartzite. All gradations from siltstone to quartzite. Unit weathers to form rubble-covered slope. *Scolithus* tubes abundant in some quartzite layers	87
Total Zabriskie Quartzite	447
Wood Canyon Formation:	
Upper member:	
38. Siltstone and quartzite. Siltstone, grayish-olive (10*Y* 4/2) to dusky-yellow (5*Y* 6/4); weathers same colors; fine to medium silt; platy. Quartzite, yellowish-gray (5*Y* 8/1) to white (*N*9); weathers same colors; very fine grained; well sorted; evenly laminated ½-in. to 2-ft layers interstratified with siltstone. Amount of quartzite increases upward in unit from about 20 percent near base to about 70 percent near top, except for top 17 ft of unit, which is mostly greenish-gray (5*GY* 6/1) silty very fine grained quartzite and minor yellowish-gray quartzite and siltstone similar to that in rest of unit. *Scolithus* tubes occur rarely in the siltstone and are very abundant in the greenish-gray quartzite in the top 17 ft of unit. Unit weathers to form steep slope. Gradational into both underlying and overlying units	136
37. Dolomite (80 percent) and quartzite (or sandstone) (20 percent). Dolomite, medium-gray (*N*5); weathers olive gray (5*Y* 4/1); medium crystalline, weathered surface giving clastic appearance; indistinctly laminated to very thin bedded; some very low angle cross-strata. Quart-	

Locality 21 (section 2)—Continued

Northern part of Resting Spring Range No. 2 section, measured on western slope of the northern part of the Resting Spring Range about 6 miles east-southeast of Eagle Mountain, east-central part of sec. 18, northern part of sec. 17, and west-central part of sec. 16, T. 24 N., R. 7 E.—Continued

Wood Canyon Formation—Continued

Upper member—Continued

	Feet
37. Dolomite (80 percent), etc.—Continued zite; same as in unit 36; 1-in. to 3-ft layers interstratified with dolomite. Dolomite commonly contains abundant pelmatozoan debris. Unit weathers to form ledgy outcrop	59
36. Quartzite (80 percent) and siltstone (20 percent). Quartzite, pale-yellowish-brown (10*YR* 6/2) to yellowish-gray (5*Y* 8/1); weathers same colors; very fine grained; sparse mica; evenly laminated; some low-high-angle small-scale cross-laminae. Siltstone, pale-olive (10*Y* 6/2) to grayish-olive (10*Y* 4/2); fine silt; micaceous; platy; ½–6-in. layers interstratified with quartzite. Unit weathers to form rubble-covered slope between dolomite units. A 1-ft dolomite, similar to that in unit above, occurs about 5 ft below top of unit	34
Section offset on top of unit 35 so that unit 36 and higher units measured starting at a point about 500 ft. S. 33° E. of the place where unit 35 was measured.	
35. Dolomite, medium-gray (*N*5); weathers olive gray (5*Y* 4/1); coarsely crystalline; granular texture on weathered surface; contains fine quartz grains in places; indistinctly laminated to thin bedded; weathers to form drab-colored ledge. Two or three faults with stratigraphic displacements of 3–10 ft occur 10–50 ft south of line of section. Unit contains some pelmatozoan plates	14
34. Dolomite (40 percent), siltstone (30 percent), and quartzite (30 percent). Dolomite, pale-yellowish-brown (10*YR* 6/2); weathers moderate yellowish brown (10*YR* 5/4); coarsely crystalline; commonly oolitic; abundant pelmatozoan plates; indistinctly laminated to very thin bedded layers 0.5–5 ft thick interstratified with siltstone and quartzite. Siltstone, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1), grayish-olive (10*Y* 4/2), and rare grayish-purple (5*P* 4/2); fine to medium silt; some mica; platy. Quartzite, yellowish-gray (5*Y* 8/1) to light-brownish-gray (5*YR* 6/1); weathers same colors and dark yellowish brown (10*YR* 4/2); very fine grained; commonly micaceous; evenly laminated; layers ½ in. to 1 ft thick interstratified with siltstone. Quartzite contains a few fragments of trilobites. A few *Scolithus* tubes	

Locality 21 (section 2)—Continued

Northern part of Resting Spring Range No. 2 section, measured on western slope of the northern part of the Resting Spring Range about 6 miles east-southeast of Eagle Mountain, east-central part of sec. 18, northern part of sec. 17, and west-central part of sec. 16, T. 24 N., R. 7 E.—Continued

Wood Canyon Formation—Continued

Upper member—Continued

	Feet
34. Dolomite (40 percent), etc.—Continued noted in siltstone in unit. Unit as a whole weathers to form ledge with prominent yellowish-brown bands (dolomite)	92
33. Quartzite (40 percent) and siltstone (60 percent); similar to unit 31. Quartzite commonly contains fragments of trilobites. *Scolithus* tubes noted throughout unit	63
32. Dolomite, pale-yellowish-brown (10*YR* 6/2); weathers moderate yellowish brown (10*YR* 5/4); medium to coarsely crystalline; a few indistinct thin beds; weathers to form small ledge. Some pelmatozoan plates	5
31. Quartzite (50 percent) and siltstone (50 percent). Quartzite, light-greenish-gray (5*GY* 8/1), greenish-gray (5*GY* 6/1), yellowish-gray (5*Y* 8/1); weathers same colors; very fine grained; evenly laminated 0.5–2-ft layers interstratified with siltstone. Siltstone, grayish-olive (5*Y* 4/2) to dusky-yellow (5*Y* 6/4); weathers same colors; fine to medium silt; common white mica; platy. Trilobite fragments occur in the quartzite in top 62 ft of unit. *Scolithus* tubes occur in some siltstone float, but none noted in place. Unit as a whole weathers to form gentle slope	103
30. Quartzitic siltstone to silty quartzite, and minor siltstone. Quartzitic siltstone to silty quartzite, brownish-gray (5*YR* 4/1), medium-gray (*N*5), and pale-yellowish-brown (10*YR* 6/2); weather dark yellowish brown (10*YR* 4/2); grade from coarse silt to very fine sand; evenly laminated; blocky. Siltstone, grayish-olive (10*Y* 4/2); weathers same color; abundant white mica; platy; occurs from 76 to 108 ft above base of unit, but may also occur in part of unit that is poorly exposed. Unit weathers to form saddle along with underlying unit; commonly forms rock piles	131
29. Siltstone, grayish-olive (5*Y* 4/2); some grayish purple (5*P* 4/2) in lower 5 ft; weathers same colors; fine to medium silt; micaceous; platy. Many tracks and burrows. Contains some interlayered medium-gray (*N*5) coarse siltstone to silty very fine grained sandstone near top of unit and grades into overlying unit. Weathers to form saddle	119
Total of upper member	756

Locality 21 (section 2)—Continued

Northern part of Resting Spring Range No. 2 section, measured on western slope of the northern part of the Resting Spring Range about 6 miles east-southeast of Eagle Mountain, east-central part of sec. 18, northern part of sec. 17, and west-central part of sec. 16, T. 24 N., R. 7 E.—Continued

Wood Canyon Formation—Continued

Middle member: *Feet*

28. Quartzite and conglomerate (90 percent) and siltstone (10 percent). Quartzite and conglomerate, grayish-purple (5*P* 4/2), grayish-red-purple (5*RP* 4/2), grayish-red (5*R* 4/2), pale-yellowish-brown (10*YR* 6/2), and yellowish-gray (5*Y* 8/1); weather dark yellowish brown (10*YR* 4/2) to grayish red (5*R* 4/2); mostly fine to medium grained, some medium-grained to very coarse grained parts. Granule and small-pebble conglomerate containing pebbles commonly as large as ⅜ in. are common in lower 200 ft; 1-ft-thick conglomerate near base of unit contains pebbles as large as 39 mm in diameter, but this is a much coarser conglomerate than any other. Quartzite and conglomerate is composed of 0.2–1-ft-thick tabular planar sets and a few trough sets of small-scale cross-laminae interlayered with scarce thinly laminated sets. Siltstone, grayish-red-purple (5*RP* 4/2); weathers same color; medium to coarse silt; micaceous; platy; occurs in sets 1 in. to 3 ft thick interstratified with the quartzite. Unit as a whole weathers to form cliff. In general unit becomes finer grained upward and contains more siltstone layers, but this is only a rough generalization — 859

Total of middle member — 859

Lower member:

27. Siltstone (80 percent) and quartzite (20 percent). Siltstone, moderate-yellowish-brown (10*YR* 6/2), medium-gray (*N*5), olive-gray (5*Y* 4/1), and greenish-gray (5*GY* 6/1); weathers dominantly dark yellowish brown (10*YR* 4/2); coarse silt, much of which is near boundary of coarse silt and very fine sand; mostly medium silt in basal 64 ft; abundant mica in some parts; evenly laminated; some slightly wavy laminae. Quartzite, yellowish-gray (5*Y* 8/1) to pale-yellowish-brown (10*YR* 6/2); weathers same colors; very fine to fine grained; evenly laminated; some low-angle cross-strata; 1-in. to 1-ft layers interstratified with siltstone. Basal 64 ft contains platy medium-grained siltstone, whereas siltstone in rest of unit is more massive and is generally coarse grained. Unit grades into overlying unit; as a whole weathers to form steep slope — 161

Locality 21 (section 2)—Continued

Northern part of Resting Spring Range No. 2 section, measured on western slope of the northern part of the Resting Spring Range about 6 miles east-southeast of Eagle Mountain, east-central part of sec. 18, northern part of sec. 17, and west-central part of sec. 16, T. 24 N., R. 7 E.—Continued

Wood Canyon Formation—Continued

Lower member—Continued *Feet*

26. Dolomite, medium-gray (*N*5); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline, almost aphanitic; some parts containing abundant fine to coarse quartz grains; laminated; some low-angle cross-laminae; weathers to form light-colored ledge — 19

25. Siltstone (80 percent) and quartzite (20 percent). Siltstone, light-olive-gray (5*Y* 5/2) and greenish-gray (5*GY* 6/1); some grayish red (5*R* 4/1) in bottom 5 ft; weathers dominantly olive gray (5*Y* 4/1); medium to coarse silt; minor amount mica; platy; trails and burrows common. Quartzite, yellowish-gray (5*Y* 8/1) and light-brownish-gray (5*YR* 6/1); weathers same colors; very fine to fine grained; abundant mica in some layers; evenly laminated; some low-angle cross-laminae; ½-in. to 10-in. layers interstratified with siltstone. A 1-ft moderate-yellowish-brown-weathering dolomite is 36 ft above base of unit. A few 0.5–1-in. dolomite layers are in top 3 ft. Unit as a whole weathers to form slope — 86

24. Dolomite and siltstone. Dolomite, medium-gray (*N*5); weathers dark yellowish brown (10*YR* 4/2); very finely crystalline; laminated; some slightly wavy laminae. Siltstone, greenish-gray (5*GY* 6/1) and pale-yellowish-brown (10*YR* 6/2); weathers same colors; fine to medium silt; platy. Bottom 11 ft and top 4 ft of unit are dolomite. Siltstone constitutes most of unit from 11 to 24 ft above base, although the siltstone in top part of this interval contains some dolomite and grades upward into the dolomite in the top 4 ft of unit. Unit as a whole weathers to form small ledge — 28

Offset in section so that unit 24 measured starting at a point about 700 ft S. 40° E. of place where unit 23 was measured. This offset crosses fault with about 100 ft of stratigraphic displacement.

23. Siltstone and minor amount quartzite. Siltstone, light-olive-gray (5*Y* 5/2) and greenish-gray (5*GY* 6/1); weathers same colors; fine to medium silt; micaceous; platy. Some siltstone is quartzitic and breaks out in large pieces. Quartzite, pinkish-gray (5*YR* 8/1) and yellowish-gray (5*Y* 8/1); weathers same colors; very fine to fine grained; evenly laminated 0.5-in. to 1-ft layers interstratified with siltstone. Quartzite constitutes less than 5 percent

Locality 21 (section 2)—Continued

Northern part of Resting Spring Range No. 2 section, measured on western slope of the northern part of the Resting Spring Range about 6 miles east-southeast of Eagle Mountain, east-central part of sec. 18, northern part of sec. 17, and west-central part of sec. 16, T. 24 N., R. 7 E.—Continued

Wood Canyon Formation—Continued

Lower member—Continued

	Feet
23. Siltstone and minor, etc.—Continued of lowest part of unit; increases in amount upward to about 50 percent at 181 ft above base and constitutes only 5 percent from 181 ft to top of unit. Unit as a whole weathers to form slope	243
22. Dolomite, medium-gray (*N*5); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline; commonly contains coarse silt to very fine quartz grains; evenly laminated; weathers to form minor ledge. Unit from 5 to 8 ft below top is composed of light-olive-gray (5*Y* 6/1) and pale-red (10*R* 6/2) platy dolomitic(?) siltstone	20
21. Siltstone and minor limy siltstone in top 34 ft. Siltstone, light-olive-gray (5*Y* 5/2) to greenish-gray (5*GY* 6/1); weathers same colors; fine to medium silt; platy. Limy siltstone, pale-yellowish-brown (10*YR* 6/2); weathers same color and dark yellowish brown (10*YR* 4/2); coarse silt; micaceous; evenly laminated 1-in. to 1.5-ft layers interstratified with siltstone. Limy siltstone constitutes about 40 percent of top 34 ft of unit. Two thin silty limestone beds that weather moderate yellowish brown (10*YR* 5/4) are in the interval from 35 to 40 ft above base of unit. Unit weathers to form slope	69
20. Quartzite (50 percent) and dolomite (50 percent). Quartzite, pale-yellowish-brown (10*YR* 6/2); weathers dark yellowish brown (10*YR* 4/2); fine-grained; evenly laminated. Dolomite, medium-gray (*N*5) to medium-light-gray (*N*6); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline; evenly laminated 1-in. to 3-ft layers interstratified with quartzite; grades through dolomitic sandstone into quartzite. Unit as a whole weathers to form minor ledge	36
Total of lower member	662
Total of Wood Canyon Formation	2,277

Stirling Quartzite:

E member:

	Feet
19. Quartzite and siltstone. Quartzite, yellowish-gray (5*Y* 8/1) and minor dark-yellowish-brown (10*YR* 4/2); weathers same colors; fine to medium grained; evenly laminated. Siltstone, light-olive-gray (5*Y* 5/2) to greenish-gray (5*GY* 6/1); weathers same colors and dark yellowish brown (10*YR* 4/2); fine to coarse silt; commonly micaceous; platy. Sequence in unit is 0–42 ft, 50 percent siltstone and 50 percent quartzite; 42–100 ft, 100 percent quartzite; 100–125 ft, 80 percent siltstone and 20 percent quartzite; and 125–167 ft, 100 percent quartzite. Quartzite is commonly dolomitic, and the dolomitic layers are dark yellowish brown. Top 6 ft of unit grades into overlying unit. Unit as a whole weathers to form slope with ledgy parts in quartzite-rich rock intervals	167
18. Quartzite, pinkish-gray (5*YR* 8/1), dominantly yellowish gray (5*Y* 8/1) in top 200 ft; weathers same colors; generally fine to medium grained; some medium-grained to very coarse grained parts; about 5 percent of unit is granule and small-pebble conglomeratic quartzite with pink and white quartz pebbles as large as 15 mm in maximum diameter; quartzite is laminated to very thin bedded; has some tabular planar and shallow trough sets of small-scale low- and high-angle cross-laminae; weathers to form prominent light-colored cliff. Top 100 ft of unit contains a few dark-yellowish-brown(10*YR* 4/2)-weathering dolomitic sandstone layers. Conglomeratic quartzite occurs from about 380 ft above base of unit to the top of the unit; it does not occur in the basal 380 ft of unit	737
Total of E member	904

D member:

17. Quartzite (85 percent), siltstone (10 percent), and dolomite (5 percent). Quartzite, yellowish-gray (5*Y* 8/1) to pale-yellowish-brown (10*YR* 6/2), white (*N*9), and pinkish-gray (5*YR* 8/1); weathers generally same colors, but dark yellowish brown (10*YR* 4/2) is also common; fine to medium grained and medium to coarse grained; some slightly dolomitic or limy parts; in places grades to sandy dolomite; evenly laminated; some tabular planar sets of small-scale cross-laminae. Siltstone, moderate-yellowish-brown (10*YR* 5/4); several thin grayish-red (5*R* 4/2) layers from 151 to 155 ft and in top 4 ft of unit; weathers same colors; medium to coarse silt; micaceous; platy. Dolomite, medium-gray (*N*5); weathers dark yellowish brown

Locality 21 (section 2)—Continued

Northern part of Resting Spring Range No. 2 section, measured on western slope of the northern part of the Resting Spring Range about 6 miles east-southeast of Eagle Mountain, east-central part of sec. 18, northern part of sec. 17, and west-central part of sec. 16, T. 24 N., R. 7 E.—Continued

Stirling Quartzite—Continued

D member—Continued

	Feet
17. Quartzite (85 percent), etc.—Continued (10*YR* 4/2) and moderate yellowish brown (10*YR* 5/4); very finely crystalline, almost aphanitic; grades to dolomitic limestone and to sandy dolomite and dolomitic quartzite; laminated; some low-angle cross-strata; 1–10-in.-thick layers interstratified with siltstone and quartzite. Most of the dolomite and siltstone is in lower 62 ft of unit. Dolomite constitutes about 20 percent and siltstone about 40 percent of the lower 62 ft of unit. Siltstone and dolomite decrease in amount rapidly above this lower 62 ft, and in the upper part of the unit the siltstone and dolomite occur only in a few scattered layers. Unit as a whole weathers to form steep slope marked by brown band at base. One or two faults with less than 10 ft of stratigraphic displacement occur within 100 ft south of line of section and at top of unit	216
16. Quartzite (60 percent) and limy and dolomitic quartzite (40 percent). Quartzite, white (*N*9); weathers same color; medium grained; some coarse grains; evenly laminated; some tabular planar sets of small-scale low-angle cross-laminae. Limy and dolomitic quartzite, pale-yellowish-brown (10*YR* 6/2); weather dark yellowish brown (10*YR* 4/2); medium-grained; some coarse to very coarse grains; some parts limy, other parts appear to be dolomitic; evenly laminated; some low-angle cross-laminae; 0.2–3-ft layers interstratified and intergrading with the white quartzite. Unit as a whole weathers to form cliff. Alternating dark and light layers give unit banded appearance. Unit contains a few layers of greenish-gray (5*GY* 6/1) and medium-light-gray (*N*6) coarse micaceous siltstone in lower 15 ft	138
15. Dolomite (70 percent) to dolomitic sandstone (30 percent), pale-yellowish-brown (10*YR* 6/2); weather moderate yellowish brown (10*YR* 5/4) to dark yellowish brown (10*YR* 4/2); dolomite is very finely crystalline, almost aphanitic in places. Composition ranges from dolomite containing a few scattered fine to coarse rounded quartz grains to dolomitic sandstone. Unit is evenly laminated; weathers to form brown slope	22
14. Quartzite (90 percent) and siltstone (10 percent). Quartzite, white (*N*9) to yellowish-gray (5*Y* 8/1); weathers same colors; medium grained; indistinct laminae to very thin beds. Siltstone, light-greenish-gray (5*GY* 8/1); weathers same color; fine to medium silt; micaceous; platy ¼–1-in. layers interstratified with quartzite. Unit as a whole weathers to form white slope	23
13. Siltstone (60 percent), quartzite (20 percent), and dolomite (20 percent). Siltstone, greenish-gray (5*GY* 6/1); fine to medium silt; micaceous; platy. Quartzite, yellowish-gray (5*Y* 8/1) to light-greenish-gray (5*GY* 8/1), fine- to medium-grained; evenly laminated; 1–6-in. layers interstratified with siltstone. Dolomite, pale-yellowish-brown (10*YR* 6/2); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline, almost aphanitic; evenly laminated; 3–10-in. layers interstratified with siltstone and quartzite. Unit as a whole weathers to form slope	22
Total of D member	421

C member:

	Feet
12. Siltstone to sandstone (80 percent) and quartzite (20 percent). Siltstone to sandstone, grayish-red-purple (5*RP* 4/2) to grayish-purple (5*P* 4/2); weather same colors; grade from medium-grained siltstone to very fine grained sandstone; siltstone is micaceous, laminated, and platy. Quartzite, yellowish-gray (5*Y* 8/1) to very light gray (*N*8); weathers same colors; fine to medium-grained; laminated layers 1 in. to 2 ft thick interstratified with siltstone to very fine grained sandstone. Amount of fine- to medium-grained quartzite increases upward in unit from about 5 percent in lower one-third to 30 percent in upper one-third. Unit as a whole weathers to form slope and saddle along with unit 11	231
11. Siltstone (80 percent) to sandstone (20 percent), dusky-yellow (5*Y* 6/4), moderate-olive-brown (5*Y* 4/4), light-olive-gray (5*Y* 5/2), light-greenish-gray (5*GY* 8/1), greenish-gray (5*GY* 6/1), and grayish-red (5*R* 4/2); fine-grained siltstone to coarse-grained siltstone and minor very fine grained sandstone; sandstone commonly silty, siltstone generally micaceous; indis-	

Locality 21 (section 2)—Continued

Northern part of Resting Spring Range No. 2 section, measured on western slope of the northern part of the Resting Spring Range about 6 miles east-southeast of Eagle Mountain, east-central part of sec. 18, northern part of sec. 17, and west-central part of sec. 16, T. 24 N., R. 7 E.—Continued

Stirling Quartzite—Continued

C member—Continued

	Feet
11. Siltstone (80 percent), etc.—Continued tinctly laminated; platy; weather to form saddle. Top 40 ft of unit is mostly greenish gray and light greenish gray	166
10. Siltstone (80 percent) and dolomite (20 percent). Siltstone, pale-red-purple (5*RP* 6/2) to grayish-red-purple (5*RP* 4/2), yellowish-gray (5*Y* 8/1), and light-greenish-gray (5*GY* 8/1); weathers same colors; fine to coarse silt (grain size is near boundary of silt and sand) platy; some micaceous parts; some quartzitic parts. Dolomite, pale-yellowish-brown (10*YR* 6/2) to dark-yellowish-brown (10*YR* 4/2), and minor medium-gray (*N*5) and grayish-red (10*R* 4/2); weathers moderate yellowish brown (10 *YR* 5/4); very finely crystalline, almost aphanitic; evenly laminated layers 1 in. to 2 ft thick interstratified with siltstone. Eight-inch dolomite layer at base contains abundant rounded medium grains of quartz. Unit as a whole weathers to form slope. Unit is made noticeable by presence of brown-weathering dolomite layers	65
Total of C member	462

B member:

9. Quartzite to quartzitic siltstone (90 percent) and coarse-grained quartzite (10 percent). Quartzite to quartzitic siltstone, grayish-red-purple (5*RP* 4/2), grayish-purple (5*P* 4/2), and grayish-red (10*R* 4/2); weather same colors; grade from very fine grained sandstone to sandy coarse siltstone. Siltstone occurs in lower 50 ft of unit, is distinctly laminated (some laminae are wavy). Coarse-grained quartzite, yellowish-gray (5*Y* 8/1); weathers same color; generally coarse grained, but grades from medium to very coarse grained; laminated 1–12-in. layers interstratified with quartzite to quartzitic siltstone. Coarse-grained quartzite is absent in lower half of unit and increases in amount upward in unit. Unit as a whole weathers to form ledgy slope. Top 20 ft of unit contains at least one-third grayish-purple siltstone, and a discontinuous layer up to 4 in. thick of dark-yellowish-brown (10*YR* 4/2) limy sandstone occurs about 10 ft below top of unit	208
Total of B member	208

Locality 21 (section 2)—Continued

Northern part of Resting Spring Range No. 2 section, measured on western slope of the northern part of the Resting Spring Range about 6 miles east-southeast of Eagle Mountain, east-central part of sec. 18, northern part of sec. 17, and west-central part of sec. 16, T. 24 N., R. 7 E.—Continued

Stirling Quartzite—Continued

NOTE.—Top 50 ft of unit 8 may also belong to B member.

A member:

	Feet
8. Quartzite, yellowish-gray (5*Y* 8/1); grayish red (5*R* 4/2), and light greenish gray (5*GY* 8/1) are common in top 50 ft (the red and greenish-gray colors become increasingly dominant upward in top 50 ft of unit and grade into reddish color of overlying unit); weathers same colors; variable grain size, from conglomerate in a few layers in basal 20 ft to very fine grained sandstone near top (conglomerate in basal 20 ft contains quartz pebbles as large as 25 mm); grain size gradually decreases upward in unit, much of basal 100 ft is medium to very coarse grained, and much of top 50 ft is very fine grained. Quartzite is laminated, with some laminae slightly wavy and has a few tabular planar(?) sets, 4–10 in. thick, of high-angle cross-laminae. Unit weathers to form white cliff. Top 50 ft of unit contains a few ¼–2-in. layers of light-greenish-gray and grayish-red siltstone	220
7. Phyllitic siltstone, and quartzite and quartzitic conglomerate. Phyllitic siltstone; same as in unit 3. Quartzite and quartzitic conglomerate, pinkish-gray (5*YR* 8/1), pale-red-purple (5*RP* 6/2), and grayish-purple (5*P* 4/2); weathering same colors and pale yellowish brown (10*YR* 6/2); grade from fine- to medium-grained quartzite to quartzitic conglomerate with granules and pebbles of quartz as large as 12 mm. About half of quartzitic rock in unit is conglomerate. Quartzite and quartzitic conglomerate indistinctly very thin to thin bedded. Sequence in unit is as follows: 0–65 ft, phyllitic siltstone; 65–84 ft, pink conglomerate and quartzite; 84–90 ft, phyllitic siltstone; 90–94 ft, purple quartzite and conglomerate; 94–111 ft, phyllitic siltstone; 111–129 ft, pink conglomerate and quartzite; 129–133 ft, phyllitic siltstone. Unit as a whole weathers to form slope	133

Offset on top of unit 6 so that overlying unit measured starting at a point 400 ft north of where underlying units were measured.

6. Quartzite, grayish-red-purple (5*RP* 4/2), pinkish-gray (5*YR* 8/1), and yellowish-gray (5*Y* 8/1); weathers dark yellowish

Locality 21 (section 2)—Continued

Northern part of Resting Spring Range No. 2 section, measured on western slope of the northern part of the Resting Spring Range about 6 miles east-southeast of Eagle Mountain, east-central part of sec. 18, northern part of sec. 17, and west-central part of sec. 16, T. 24 N., R. 7 E.—Continued

Stirling Quartzite—Continued
A member—Continued

	Feet
6. Quartzite, grayish-red-purple, etc.—Con. brown (10*YR* 4/2) and grayish red (10*R* 4/2); medium to very coarse grained; some conglomeratic parts with granules and pebbles of quartz as large as 13 mm in maximum diameter; indistinct layers ½–2 ft thick; some tabular planar(?) sets of small-scale low- and high-angle cross-laminae; a few medium-scale cross-laminae; weathers to form cliff. Lower half of unit contains at least three phyllitic siltstone layers 0.5–2 ft thick	160
5. Phyllitic siltstone and quartzite. Phyllitic siltstone; same as in unit 3. Quartzite, grayish-purple (5*P* 4/2); weathers same color; fine to coarse grained; indistinctly thin bedded; occurs as a single layer from 8 to 21 ft above base of unit	48
4. Quartzite, pale-red-purple (5*RP* 6/2) to grayish-purple (5*P* 4/2), and pinkish-gray (5*YR* 8/1); weathers grayish red (5*R* 4/2 and 10*R* 4/2); fine to very coarse grained; some conglomeratic parts with granules and pebbles of quartz as large as 11 mm; composed of laminated sets to thin beds and tabular planar(?) sets of small-scale low- to high-angle cross-strata; weathers to form ledge	142
3. Phyllitic siltstone (85 percent) and quartzite (15 percent). Phyllitic siltstone, grayish-red-purple (5*RP* 4/2) to grayish-purple (5*P* 4/2); weathers same colors; fine to medium silt; micaceous; platy. Quartzite, light-greenish-gray (5*GY* 8/1), yellowish-gray (5*Y* 8/1), and grayish-red-purple (5*P* 4/2); weathers same colors; fine to medium grained; indistinctly laminated 1–10-in. layers interstratified with the phyllitic siltstone. Unit as a whole weathers to form slope	93
2. Quartzite and conglomeratic quartzite; yellowish-gray (5*Y* 8/1) to pinkish-gray (5*YR* 8/1) to white (*N*9); weather same colors and pale yellowish brown (10*YR* 6/2); medium to very coarse grained; some conglomeratic parts with quartz granules and pebbles as large as 6 mm; indistinct layers 0.5–2 ft thick; some low-angle cross-strata; weather to form whitish band at base of Stirling Quartzite. Rock appears altered, and grain size and stratification of unit are difficult to see. Unit thin, apparently because of faulting at base. Two miles to southeast, this unit is at least 483 ft thick	175
Total of A member (thin because of faulting; see note below)	971
Total of Stirling Quartzite (thin because of faulting; see note below)	2,966+

NOTE.—Contact of Stirling Quartzite and Johnnie Formation is sharp, but is probably site of some structural movement, which is indicated by the sheared character of Johnnie Formation and by fractures and alteration of Stirling Quartzite. The total thickness of the Stirling Quartzite is probably too thin because of this faulting. Unit 2 is at least 483 ft thick, 2 miles to southeast, and using this figure the thickness of the A member would be 1,279 ft and total thickness of the Stirling Quartzite would be 3,274 ft.

Johnnie Formation:

1. Siltstone, greenish-gray (5*GY* 6/1); minor amounts grayish red (10*R* 4/2) and grayish orange (10*YR* 7/4) in top 10 ft; weathers same colors; fine to medium silt; sparse mica; irregularly platy; weathers to form steep slope. About 100 ft exposed	Unmeasured

Locality 23

Black Mountain section, measured about 2½ miles east-northeast of Ashford Mill, central and northeastern part of sec. 15 (unsurveyed) and northwestern part sec. 14 (unsurveyed), T 21 N., R. 3 E.

[Measured by J. H. Stewart, November 1964]

Stirling Quartzite (incomplete):
C member (incomplete):

	Feet
34. Siltstone to silty very fine grained quartzite and sparse (4 percent) dolomite. Siltstone to silty very fine grained quartzite, grayish-red (5*R* 4/2), minor amounts pale-red (5*R* 6/2); mostly light greenish gray (5*GY* 8/1) in top 10 ft; grade from fine-grained siltstone to silty very fine grained sandstone; laminated; mostly siltstone in lower half grading upward to about 50 percent quartzite in upper half. Dolomite, pale-yellowish-brown (10*YR* 6/2); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline to aphanitic; probably silty; 1–4 in. layers interstratified throughout unit. Top of unit not exposed; top is probably a fault,	

Locality 23—Continued

Black Mountain section, measured about 2½ miles east-northeast of Ashford Mill, central and northeastern part of sec. 15 (unsurveyed) and northwestern part sec. 14 (unsurveyed), T. 21 N., R. 3 E.—Continued

Stirling Quartzite (incomplete)—Continued

C member (incomplete)—Continued

	Feet
34. Siltstone to silty very fine, etc.—Continued bringing probable Johnnie Formation in contact with unit. Unit weathers to form slope	45
NOTE.—About 150 ft to north is a prominent outcrop of moderate-yellowish-brown-weathering dolomite. The dolomite layers constitute about 50 percent of a 25±ft interval and cannot be tied into measured section. The dolomite is probably part of the Johnnie Formation (Rainstorm? Member) thrust over the Stirling.	
33. Quartzite, yellowish-gray (5*Y* 8/1), medium- to coarse-grained, laminated; some inclination to laminate in places; weathers to form white ledge	2
32. Dolomite and siltstone. Dolomite, grayish-red (5*R* 4/2); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline. Siltstone; similar to that in unit 30. Dolomite forms a 4-in. layer at base of unit and a 5-in. layer from 10 to 5 in. below top of unit. Upper dolomite contains fine to medium quartz grains	4
Total of incomplete C member	51

B member:

31. Quartzite and minor siltstone. Quartzite, grayish-red (5*R* 4/2) and minor yellowish-gray (5*Y* 8/1), very fine- to fine-grained; micaceous in places; laminated; rare low-angle cross-strata. Siltstone, grayish-red (5*R* 4/2); coarse silt; micaceous; very thin to thin layers in top 65 ft of unit. From 65 to 87 ft above base, unit contains about 40 percent grayish-red (5*R* 4/2) and yellowish-gray (5*Y* 8/1) fine- to medium-grained cross-stratified quartzite in layers 0.5–2 ft thick. Unit as a whole weathers to form slope. Thickness of unit uncertain because of faulting, and thickness given, although measured with Jacob's staff, is not much more than an estimate	100(?)
Total of B member	100(?)

Offset in section so that unit 31 measured 500 ft southeast of unit 30.

A member:

30. Quartzite, yellowish-gray (5*Y* 8/1), fine- to medium-grained and medium- to coarse-grained, laminated to thin-bedded; abundant small-scale low-angle cross-strata; weathers to form prominent cliff. Where measured, unit may be in fault contact

Locality 23—Continued

Black Mountain section, measured about 2½ miles east-northeast of Ashford Mill, central and northeastern part of sec. 15 (unsurveyed) and northwestern part sec. 14 (unsurveyed), T. 21 N., R. 3 E.—Continued

Stirling Quartzite (incomplete)—Continued

A member—Continued

	Feet
30. Quartzite, yellowish-gray, etc.—Continued with unit 31. Thickness may be too thin although probably by not more than 50 ft	205±
29. Siltstone to silty sandstone and minor quartzite. Siltstone to silty sandstone, grayish-red (5*R* 4/2); grade from fine-grained siltstone to silty very fine grained sandstone; micaceous; platy in part. Quartzite, yellowish-gray (5*Y* 8/1) and rare medium-gray (*N*5), fine- to medium-grained; minor amounts of medium- to coarse-grained material containing scattered very coarse grains and granules of quartz; laminated to thin bedded; minor small-scale cross-strata. Quartzite forms ½-in. to 9-ft layers; thickest layers are in following positions: 11–13 ft, 25–34 ft, and 59–64 ft. Unit as a whole weathers to form slope with minor ledges on quartzite layers	77
28. Quartzite, pale-red (5*R* 6/2), yellowish-gray, and rare grayish-red (5*R* 4/2), fine- to medium-grained; some medium- to coarse-grained parts; scattered very coarse grains and granules in some layers; highly fractured; obscure stratification; weathers to form cliffy outcrop. Thickness of unit quite uncertain because of faulting; may be thicker than 190 ft	190±
27. Quartzite and minor amount of siltstone to silty sandstone. Quartzite, pale-red (5*R* 6/2) to grayish-red (5*R* 4/2), medium- to coarse-grained, fractured; stratification difficult to see, probably thin bedded in part. Siltstone to silty sandstone, grayish-red (5*R* 6/2); fine-grained siltstone to very fine grained silty sandstone; micaceous; platy in parts; occur in following positions: 28–30 ft, 44–48 ft, 73–75 ft, and 86–110 ft. Unit as a whole weathers to form purplish slope. In places along outcrops, basal 30± ft of unit is yellowish gray (5*Y* 8/1)	110
26. Conglomerate, pale-red (5*R* 6/2); composed of granules and pebbles (as large as 1.2 in.) of quartz, quartzite, and jasper set in fine- to very fine-grained matrix; structureless; forms part of cliff with unit 27	6

Offset in section so that unit 26 measured 700 ft north of unit 25.

25. Quartzite, grayish-red (5*R* 4/2), fine-grained; commonly fine- to medium-grained in parts; laminated; minor very low angle small-scale cross-strata; ripple-marked layers common; weathers to form

Locality 23—Continued

Black Mountain section, measured about 2½ miles east-northeast of Ashford Mill, central and northeastern part of sec. 15 (unsurveyed) and northwestern part sec. 14 (unsurveyed), T. 21 N., R. 3 E.—Continued

Stirling Quartzite (incomplete)—Continued

A member—Continued

	Feet
25. Quartzite, grayish-red, etc.—Continued slope. Lower 25 ft of unit contains a minor amount of grayish-red (5*R* 4/2) micaceous siltstone and is transitional into unit 24. Unit from 4.0 to 4.5 ft and 8 to 9 ft above base contains dolomitic(?) sandstone layers. Unit as measured at two different places along outcrop gave thicknesses of 50 and 75 ft. The latter thickness appears to be more accurate because outcrops were better and structural complexities were fewer in area of measurement	75
Total of A member	663±
Total of incomplete Stirling Quartzite	814±

Johnnie Formation:

Rainstorm Member:

Siltstone and quartzite unit:

	Feet
24. Siltstone to quartzitic sandstone, grayish-red (5*R* 4/2), greenish-gray (5*GY* 6/1), light-olive-gray (5*Y* 6/1), pale-yellowish-brown (5*YR* 6/2), and light-brownish-gray (5*YR* 6/1); grade from fine silt to very fine grained sandstone; commonly micaceous; laminated to very thin bedded; platy in places, but mostly break into angular fragments; weather to form slope. The siltstone is quartzitic in about 20 percent of lower 60 ft of unit, 60 percent of interval from 60 to 215 ft, 10 percent from 215 to 260 ft, and 50 percent from 215 to 288 ft. Unit contains some dolomite and limy dolomite layers; the dolomite and limy dolomite are pale red (5*R* 6/2) to pale yellowish brown (10*YR* 6/2), weather moderate yellowish brown (10*YR* 5/4), and are finely crystalline; in some places the dolomite is laminated, and in other places, it is composed of flat pellets of dolomite in a dolomite matrix (intraformational conglomerate). The dolomite is commonly sandy (very fine). Dolomite and limy dolomite form a layer from 60 to 63 ft above base of unit and constitute 20 percent of unit from 160 to 179 ft above base; they also form a few very thin layers elsewhere in unit. Four layers of grayish-red (5*R* 4/2) dark-yellowish-brown (10*YR* 5/4)-weathering sandy (very fine) dolomite and dolomite occur in top 42 ft of unit; these layers are in following positions: 258–259 ft, 265–266 ft, 280–281 ft, and 287–290 ft; they form prominent dark band near top of unit; the sandy dolomite from 289 to 290 ft is composed of small-scale cross-strata	300
Total of siltstone and quartzite unit	300

Carbonate unit:

	Feet
23. Siltstone to limy siltstone (70 percent) and limestone (30 percent). Siltstone to limy siltstone, pale-red (5*R* 6/2) to grayish-red (5*R* 4/2); weather same colors and dark yellowish brown (10*YR* 4/2); fine to coarse silt; may grade into very fine sand; micaceous in nonlimy parts, but most of siltstone is limy (perhaps only one-tenth is not conspicuously limy); laminated to very thin bedded; rare very low angle inclined laminae (small scour fillings?). Limestone, pale-red (5*R* 6/2), very finely crystalline; silty in parts; laminated 1-in. to 4-ft layers interstratified with siltstone to limy siltstone. Unit contains a continuous gradation of rock types from siltstone, limy siltstone, silty limestone, to limestone. Unit as a whole weathers to form cliff. Basal 4 ft of unit is grayish-orange (10*YR* 7/4)-weathering limy dolomite that forms conspicuous orange band on outcrop	165
Total of carbonate unit	165

Siltstone unit:

	Feet
22. Coarse siltstone to silty very fine grained sandstone, light-brownish-gray (5*YR* 6/1), grayish-red (5*R* 4/2), and light-olive-gray (5*Y* 6/1), laminated to very thin bedded; weathers to form slope. Top 7 ft of unit contains dolomitic siltstone that weathers moderate yellowish brown (10*YR* 5/4)	33
21. Siltstone, grayish-red (5*R* 4/2); fine silt; platy; weathers to form slope	12
20. Dolomite (Johnnie oolite), very pale orange (10*YR* 8/2); weathers gray-	

Locality 23—Continued

Black Mountain section, measured about 2½ miles east-northeast of Ashford Mill, central and northeastern part of sec. 15 (unsurveyed) and northwestern part sec. 14 (unsurveyed), T. 21 N., R. 3 E.—Continued

Johnnie Formation—Continued
Rainstorm Member—Continued
Siltstone unit—Continued

	Feet
20. Dolomite, etc.—Continued ish orange (10*YR* 7/4); composed of well-defined oolites about 1–2 mm across; indistinctly laminated to very thin bedded; some structureless appearing; parts weathers to form lodge	7
Offset in section on top of unit 19 so that unit 20 measured 1,000 ft to north.	
19. Siltstone; dusky yellow (5*Y* 6/4) in bottom 12 ft, grayish red (5*R* 4/2) from 12 to 30 ft, and light greenish gray (5*GY* 8/1) in top 2 ft; fine to coarse silt; minor amount of mica; platy; weathers to form slope	32±
Total of siltstone unit	84
Total of Rainstorm Member	549
Upper carbonate-bearing member:	
18. Quartzite (90 percent) and siltstone (10 percent). Quartzite, pale-yellowish-brown (10*YR* 6/2), pale-red (5*R* 6/2), and minor amounts yellowish-gray (5*Y* 8/1), very fine grained; micaceous in part; laminated; platy in parts. Siltstone, light-greenish-gray (5*GY* 8/1) to greenish-gray (5*GY* 6/1); fine to coarse silt; micaceous; platy; very thin to thin layers interstratified with quartzite. Unit as a whole weathers to form ledgy slope. Unit characterized by pale-red quartzite layers that constitute about 20 percent of unit. Unit generally similar to unit 17. Quartzite in places is dolomitic and weathers moderate yellowish brown (10*YR* 5/4). One very thin lens of dolomite occurs about one-third of way up in unit	27
17. Siltstone grading in places to silty sandstone; grayish red (5*R* 4/2) and grayish olive (5*Y* 4/2), colors commonly intermixed and mottled; coarse silt and very fine grained sand; commonly micaceous; laminated; some platy splitting; weathers to form slope	40
16. Quartzite to dolomitic quartzite (60 percent), dolomite (30 percent), and siltstone (10 percent). Quartzite to dolomitic quartzite, pale-red (5*R* 6/2), pale-yellowish-brown (10*YR* 6/2), yellowish-gray (5*Y* 8/1), and minor amounts greenish-gray (5*GY* 6/1), very fine grained, laminated; about 25 percent is dolomitic and weathers dark yellowish brown (10*YR* 4/2). Dolomite, pale-yellowish-brown	

Locality 23—Continued

Black Mountain section, measured about 2½ miles east-northeast of Ashford Mill, central and northeastern part of sec. 15 (unsurveyed) and northwestern part sec. 14 (unsurveyed), T. 21 N., R. 3 E.—Continued

Johnnie Formation—Continued
Upper carbonate-bearing member—Continued

	Feet
16. Quartzite to dolomite quartzite, etc.—Con. (10*YR* 6/2), light-olive-gray (5*Y* 6/1), and moderate-yellowish-brown (10*YR* 5/4); weathers moderate yellowish brown (10*YR* 5/4); aphanitic to very finely crystalline; rarely contains flecks of mica; some silty parts; laminated 1-in. to 2-ft layers interstratified with rest of unit. Siltstone, greenish-gray (5*GY* 6/1) and dusky-yellow (5*Y* 6/4); fine to coarse silt; micaceous; platy. Unit as a whole weathers to form ledgy slope	50
15. Dolomite, medium-dark-gray (*N*4); weathers same color in lower 7 ft and moderate yellowish brown (10*YR* 5/4) in top 3 ft; aphanitic to very finely crystalline; evenly and thinly laminated; weathers to form prominent dark-gray ledge	10
14. Dolomite to sandy dolomite (60 percent), quartzite (35 percent), and siltstone (5 percent). Dolomite to sandy dolomite, light-olive-gray (5*Y* 6/1) and rare pale-yellowish-brown (10*YR* 6/2); weather grayish orange (10*YR* 7/4) to moderate yellowish brown (10*YR* 5/4); aphanitic to very finely crystalline; rarely (15 percent) contain 10–50 percent fine to medium grains of quartz; laminated to thin bedded. Quartzite, pale-yellowish-brown (10*YR* 6/2) and minor amount grayish-red (5*R* 6/2), fine-grained; sparse fine- to medium-grained parts; laminated to very thin bedded. Siltstone, moderate-yellowish-brown (10*YR* 5/4); fine to medium silt; some mica; platy; very thin to thin layers interstratified with rest of unit. Unit as a whole weathers to form prominent light colored somewhat variegated ridge. Dolomite contains very thin lenses of chert at 60 ft and at 112 ft; these lenses are about 1–2 ft long and 0.4 ft thick	155
13. Quartzite, pale-brown (5*YR* 5/2) to pale-yellowish-brown (10*YR* 6/2), very fine grained, indistinctly laminated to thin-bedded; weathers to form slope. Unit contains a 1-ft layer of dolomite about 1 ft above base of unit and a 0.5-ft layer of dolomite in middle of unit; this dolomite is similar to that in unit 12	28
12. Dolomite, light-olive-gray (5*Y* 6/1); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline; laminated; weathers to form ledge. A thin light-greenish-gray (5*GY* 8/1) sandy siltstone layer occurs in middle of unit	9

Locality 23—Continued

Black Mountain section, measured about 2½ miles east-northeast of Ashford Mill, central and northeastern part of sec. 15 (unsurveyed) and northwestern part sec. 14 (unsurveyed), T. 21 N., R. 3 E.—Continued

	Feet
Johnnie Formation—Continued	
Upper carbonate-bearing member—Continued	
11. Quartzite (60 percent), siltstone (35 percent), and dolomite (5 percent). Quartzite, grayish-red (5*R* 4/2), and minor amount pale-yellowish-brown (5*YR* 6/2) and yellowish-gray (5*Y* 8/1), very fine grained, micaceous, laminated. Siltstone, grayish-red (5*R* 4/2), light-greenish-gray (5*GY* 8/1), and yellowish-gray (5*Y* 8/1); fine to coarse silt; micaceous; platy. Dolomite; similar to that in unit 10; forms three thin layers from 18 to 20 ft above base of unit and a single layer from 30 to 33 ft and constitutes 40 percent of the top 14 ft of unit. Unit as a whole weathers to form steep slope. Siltstone is most abundant in lower half of unit, and quartzite in upper half	88
10. Dolomite, light-olive-gray (5*Y* 6/1) to medium-gray (*N*5), and grayish-red (5*R* 4/2); weathers moderate yellowish brown (10*YR* 5/4) to dark yellowish orange (10*YR* 6/6); very finely crystalline to aphanitic; laminated; weathers to form ledge	6
Total of upper carbonate-bearing member	413
Siltstone member:	
9. Siltstone (60 percent) and quartzitic sandstone (40 percent). Siltstone, light-greenish-gray (5*GY* 8/1) to yellowish-gray (5*Y* 8/1) and pale-red (5*R* 6/2) to grayish-red (5*R* 4/2), gray and red colors commonly irregularly intermixed; fine to coarse silt; micaceous; platy. Quartzitic sandstone, pale-yellowish-brown (10*YR* 6/2) to grayish-red (5*R* 4/2), very fine grained, commonly micaceous, laminated, platy to flaggy; in 1-in. to 4-ft layers interstratified with siltstone. Unit as a whole weathers to form gentle slope. Unit contains a few (2 percent) olive-gray (5*Y* 4/1) and moderate-yellowish-brown (10*YR* 5/4) (weathers latter color) dolomite to silty dolomite layers 0.5–1 ft thick. Unit is crushed and broken by small faults and thickness is uncertain. Measured thickness probably too small. Thickness of unit was measured at two places about 500 ft apart on outcrop; at one place was 300 ft and at the other place, 310 ft	300±
Total of siltstone member	300±

Locality 23—Continued

Black Mountain section, measured about 2½ miles east-northeast of Ashford Mill, central and northeastern part of sec. 15 (unsurveyed) and northwestern part sec. 14 (unsurveyed), T. 21 N., R. 3 E.—Continued

	Feet
Johnnie Formation—Continued	
Lower carbonate-bearing member:	
8. Sandy dolomite (50 percent) and quartzite (50 percent). Sandy dolomite, pale-yellowish-brown (10*YR* 6/2) and minor amount grayish-red (5*R* 4/2); weathers moderate yellowish brown (10*YR* 5/4); composed of medium to very coarse sand grains set in dolomite matrix, in most places sand and dolomite are probably intermixed in about equal proportions; laminated to thin bedded; minor low-angle small-scale cross-strata. Quartzite, yellowish-gray (5*Y* 8/1) to pinkish-gray (5*YR* 8/1), medium- to coarse-grained, laminated; rare low-angle small-scale cross-strata. Quartzite and sandy dolomite interlayered in units 1–10 ft thick; amount of sandy dolomite increases upward in unit, and top 9 ft of unit is entirely sandy dolomite. Unit as a whole weathers to form ridge with prominent dark-brown-weathering ledge at top	55
Total of lower carbonate-bearing member	55
Offset on top of unit 7 so that unit 8 measured 500 ft south.	
Quartzite member:	
7. Quartzite, yellowish-gray (5*Y* 8/1), and minor amount pale-yellowish-brown (10*YR* 6/2) and pale-red (5*R* 6/2), medium-to coarse-grained; some fine-grained parts; laminated to thin bedded; weathers to form prominent ridge. Basal 14 ft of unit weathers grayish yellow (5Y 8/4) and forms a conspicuous light-colored band on outcrop. The basal 14 ft contains, in addition to quartzite, a few thin layers of light-greenish-gray (5*GY* 8/1) siltstone and a thin layer of yellowish-gray (5*Y* 8/1) conglomerate containing granules and pebbles (as large as 14 mm); conglomerate is 4 ft above base of unit	55
6. Quartzite to dolomitic quartzite, and dolomite. Quartzite to dolomitic quartzite, yellowish-gray (5*Y* 8/1) to pale-yellowish-brown (10*YR* 6/2); weather same colors, dolomitic part weathering dark yellowish brown (10*YR* 4/2); fine to coarse grained; contain in some parts scattered granules and small pebbles; laminated to very thin bedded; rare low-angle small-scale cross-strata. Dolomite, grayish-red (5*R* 4/2); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline; commonly sandy with fine to	

Locality 23—Continued

Black Mountain section, measured about 2½ miles east-northeast of Ashford Mill, central and northeastern part of sec. 15 (unsurveyed) and northwestern part sec. 14 (unsurveyed), T. 21 N., R. 3 E.—Continued

	Feet
Johnnie Formation—Continued	
Quartzite member—Continued	
6. Quartzite to dolomitic, etc.—Continued coarse grains; contains in some parts scattered very coarse grains, granules, and small pebbles (as large as 21 mm) of quartz; laminated to very thin bedded. Sandy dolomite gradational into dolomitic quartzite. Unit as a whole forms dark-brown-weathering saddle. Sequence in unit is as follows: 0–40 ft, quartzite with sparse (5 percent) dolomitic quartzite and dolomite; 40–58 ft, quartzite to dolomitic quartzite (80 percent), dolomite (20 percent); 58–80 ft, dolomite (90 percent), quartzite (10 percent); 80–127 ft, quartzite to dolomitic quartzite (90 percent), dolomite (10 percent). Dolomite layers from 58 to 80 ft form prominent brown band. Unit contains a few very thin moderate-yellowish-brown (10*YR* 5/4) siltstone layers	127
5. Quartzite, pinkish-gray (5*YR* 8/1) to yellowish-gray (5*Y* 8/1), fine- to coarse-grained; rare conglomeratic layers in lower 50 ft contain granules and small pebbles of white quartz; stratification mostly obscured by fracturing; some parts laminated to very thin bedded. Unit weathers to form prominent white ridge. Unit is highly fractured; has some minor faults and small folds. Thickness uncertain, but probably correct within 30–40 ft	150±
4. Siltstone, light-greenish-gray (5*GY* 8/1) to pale-greenish-yellow (10*Y* 8/2); fine silt; forms platy to irregular fragments when broken; weathers to form slope; poorly exposed	15±
Total of quartzite member	347±
Transitional member:	
3. Dolomite to sandy dolomite (60 percent), quartzite (35 percent), and siltstone (5 percent). Dolomite to sandy dolomite, pale-red (5*R* 6/2) and olive-gray (5*Y* 4/1) to light-olive-gray (5*Y* 6/1); weathers moderate yellowish brown (10*YR* 5/4); grade from nearly pure dolomite to sandy dolomite containing abundant medium to coarse quartz grains; in a few layers contain scattered granules and pebbles (as large as 14 mm); laminated; common low-angle small-scale cross-strata. Perhaps three-fourths of dolomitic rocks	

Locality 23—Continued

Black Mountain section, measured about 2½ miles east-northeast of Ashford Mill, central and northeastern part of sec. 15 (unsurveyed) and northwestern part sec. 14 (unsurveyed), T. 21 N., R. 3 E.—Continued

	Feet
Johnnie Formation—Continued	
Transitional member—Continued	
3. Dolomite to sandy dolomite, etc.—Con. are sandy dolomite; sandy dolomite grades into dolomitic quartzite. Quartzite, pale-red (5*R* 6/2) to yellowish-gray (5*Y* 8/1), fine- to medium-grained; some medium- to coarse-grained parts; laminated 0.5–5-ft sets. Siltstone, grayish-red (5*R* 4/2) to moderate-yellowish-brown (10*YR* 5/4); fine silt; platy; very thin to thin layers. Unit as a whole weathers to form ledgy slope	145
2. Quartzite and minor (10 percent) siltstone. Quartzite, pale-red (5*R* 6/2) to yellowish-gray (5*Y* 8/1), fine-grained to very coarse grained; a few layers containing granules and small pebbles (as large as 10 mm in maximum diameter); laminated to very thin bedded; rare low-angle small-scale cross-strata. Siltstone, light-greenish-gray (5*GY* 8/1); fine to coarse silt, grading to silty very fine grained sandstone; some mica; platy. Unit as a whole weathers to form ledge. Contact of units 1 and 2 is not well exposed, but appears to be conformable and can be traced along outcrop for at least 1,000 ft	55
Total of transitional member	200
Total of Johnnie Formation	1,864
Noonday Dolomite	
1. Dolomite, pale-red (5*R* 6/2); weathers pale yellowish brown (10*YR* 6/2); coarsely crystalline; indistinctly laminated in part, structureless in part; weathers to form cliff. Commonly contains scattered fine to very coarse quartz grains. Only top 10 ft examined	Unmeasured

Locality 26

Nopah Range section, measured in southern part of Nopah Range about 1 mile east of Gunsight mine and 1½ miles north northwest of Noonday mine, northern part sec. 10, T. 20 N., R. 8 E.

[Measured by J. H. Stewart, November 1963, including data from Hazzard (1937a, p. 278)]

	Feet
Wood Canyon Formation:	
Upper member:	
23. Siltstone and fine-grained quartzite. Unit consists mostly of dolomite from 153 to 273 ft below top. Units 4D, 4E, 4F, and 4G of Hazzard (1937a, p. 278); thickness from Hazzard	706

Locality 26—Continued

Nopah Range section, measured in southern part of Nopah Range about 1 mile east of Gunsight mine and 1½ miles north northwest of Noonday mine, northern part sec. 10, T. 20 N., R. 8 E.—Con.

	Feet
Wood Canyon Formation—Continued	
Middle member:	
22. Quartzite, fine- to medium-grained; minor amounts of siltstone. Scarce conglomeratic parts in lower few hundred feet. Units 4B and 4C of Hazzard (1937a, p. 278); thickness from Hazzard	1,135
Lower member:	
21. Siltstone (50 percent) to sandstone (50 percent), pale-yellowish-brown (10*YR* 6/2) to dark-yellowish-brown (10*YR* 4/2); grades from coarse siltstone to very fine grained sandstone; indistinctly laminated to thin bedded; weathers to form slope. Top 2 ft of unit is grayish-yellow-green (5*GY* 7/2) laminated siltstone containing common amounts of fine to medium quartz grains along some bedding surfaces	27
20. Dolomite and minor (10 percent) dolomitic sandstone. Dolomite, medium-light-gray (*N*6), very finely crystalline, almost aphanitic, evenly laminated to very thin bedded; commonly contains fine to medium quartz grains and grades to dolomitic sandstone. Dolomitic sandstone, pale-yellowish-brown (10*YR* 6/2), fine-grained to very coarse grained, laminated; occurs in 1–4-in. layers	10
19. Siltstone (80 percent) and quartzite (20 percent); similar to unit 17, except unit contains some moderate-yellowish-brown (10*YR* 5/4) dolomitic siltstone and a few 1–4-in. dolomite layers in lower 4 ft	14
18. Dolomite, medium-gray (*N*5) to medium-light-gray (*N*6); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline, almost aphanitic; indistinct laminae to thin beds; weathers to form minor ledge. Some scattered fine to medium sand grains in lower few inches	15
17. Siltstone (80 percent) and quartzite (20 percent). Siltstone, pale-olive (10*Y* 6/2), rare moderate-yellowish-brown (10*YR* 5/4); fine to medium silt; common mica; platy splitting. Quartzite, brownish-gray (5*YR* 4/1) and rare olive-gray (5*Y* 4/1), very fine grained, evenly laminated; some very low angle cross-strata; occurs as ½-in. to 1-ft layers interstratified with siltstone. A few 1–10-in.-thick layers of dolomite, similar to that in unit 16, occur in basal 25 ft of unit. Unit weathers to form slope	150
16. Dolomite, and siltstone to sandstone. Dolomite, medium-gray (*N*5); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline; evenly laminated. Siltstone to sandstone, silty strata mostly grayish olive (10*Y* 4/2) and sandy strata mostly pale yellowish	

Locality 26—Continued

Nopah Range section, measured in southern part of Nopah Range about 1 mile east of Gunsight mine and 1½ miles north northwest of Noonday mine, northern part sec. 10, T. 20 N., R. 8 E.—Con.

	Feet
Wood Canyon Formation—Continued	
Lower member—Continued	
16. Dolomite, and siltstone, etc.—Continued brown (10*Y* 4/2); grade from fine-grained siltstone to silty very fine grained sandstone; mostly micaceous; siltstone is platy splitting; sandstone is mostly laminated. Dolomite forms prominent ledge in top 5 ft of unit and occurs rarely in rest of unit	14
Total of lower member	230
Total of Wood Canyon Formation	2,071
Stirling Quartzite:	
E member:	
15. Quartzite, pale-yellowish-brown (10*YR* 6/2) and greenish-gray (5*GY* 6/2), very fine grained, evenly laminated; weathers to form minor ledge	42
14. Quartzite and sandy dolomite to dolomitic sandstone. Quartzite, yellowish-gray (5*Y* 8/1), fine- to medium-grained, laminated to thin-bedded. Sandy dolomite to dolomitic sandstone, light-olive-gray; weather light brown (5*YR* 6/4); composed of fine to very coarse quartz grains and finely crystalline dolomite; evenly laminated; occur as a 2-ft layer at base and as a 3-ft layer at top of unit. A 4-in. light-brown siltstone layer occurs 15 ft above base of unit	20
13. Quartzite, yellowish-gray (5*Y* 8/1) and greenish-gray (5*GY* 6/1); mostly fine to medium grained; mostly laminated to thin bedded; some small-scale cross-strata. Conglomerate occurs from 23 to 25 ft above base and contains pebbles as large as 25 mm in maximum diameter. Sequence in unit is as follows: 0–12 ft, greenish-gray quartzite; 12–35 ft, yellowish-gray quartzite; 35–45 ft, greenish-gray quartzite with a few greenish-gray siltstone laminae; 45–57 ft, yellowish-gray quartzite	57
12. Quartzite and minor conglomerate, pinkish-gray (5*YR* 8/1), yellowish-gray (5*Y* 8/1), and rare pale-red (5*R* 6/2); entirely yellowish gray (5*Y* 8/1) in top 200 ft; fine to coarse grained; conglomerate parts containing granules and pebbles (as large as 39 mm in maximum diameter); composed of laminae, very thin beds, and cross-strata; cross-strata occur mostly in tabular planar sets 4–10 in. thick; minor amounts of shallow trough sets occur. Unit weathers to form prominent hogback. Conglomerate occurs almost entirely from 385 ft to 550 ft above base of unit and in this interval constitutes about 10 percent of rock. Top 125 ft of unit measured down long dip slope; thus, thickness determination in this	

Locality 26—Continued

Nopah Range section, measured in southern part of Nopah Range about 1 mile east of Gunsight mine and 1½ miles north northwest of Noonday mine, northern part sec. 10, T. 20 N., R. 8 E.—Con.

Stirling Quartzite—Continued

E member—Continued

	Feet
12. Quartzite and minor, etc.—Continued part of unit probably not too accurate. Some faulting can be seen, particularly along top contact of unit; faults appear to have a stratigraphic displacement of 10–20 ft	690
Total of E member	809

D member:

11. Quartzite (80 percent) and limy sandstone (20 percent). Quartzite, pale-yellowish-brown (10*YR* 6/2) and minor greenish-gray (5*GY* 6/1); weathers same colors and dark yellowish brown (10YR 4/2); fine to medium grained; laminated; minor small-scale cross-strata (sets 4–8 in. thick). Limy sandstone, pale-yellowish-brown (10*YR* 6/2) to dark-yellowish-brown (10*YR* 4/2); weathers same colors; fine to medium grained; laminated; occurs as 0.5–2-ft layers interstratified with quartzite. Limy sandstone probably contains as much as 30 percent carbonate, but all gradations from quartzite to limy sandstone occur. Contact with overlying unit indefinite. Some faulting probably occurs in interval from top of unit 9 into base of unit 12, but the faults appear to be small with displacement of 10 ft or less	108
10. Quartzite (60 percent), siltstone (30 percent), and dolomitic sandy limestone to sandy dolomite (10 percent). Quartzite, grayish-red (5*R* 4/2), pale-red (5*R* 6/2), and minor yellowish-gray (5*Y* 8/1); mostly fine to medium grained; some silty very fine to fine grained parts; mostly laminated; some low-angle small-scale cross-laminae. Siltstone, grayish-red (5*R* 4/2) and minor greenish-gray (5*GY* 6/1); fine to coarse silt; micaceous; platy splitting; occurs in several 0.5–4-ft layers. Dolomitic sandy limestone to sandy dolomite, pale-yellowish-brown (10*YR* 6/2) to grayish-orange (10*YR* 7/4); weather same colors and dark yellowish brown (10*YR* 4/2); finely crystalline; contain 20–50 percent rounded fine to coarse quartz grains; evenly laminated; occur as 3-in. layer at 14 ft, as 1-ft layer from 20 to 21 ft, as several thin layers from 33 to 37 ft, and perhaps also as a layer or two in top 10 ft of unit. Top 10 ft of unit poorly exposed. Basal 5 ft of unit is a fairly prominent yellowish-gray ledge	47
Total of D member	155

Locality 26—Continued

Nopah Range section, measured in southern part of Nopah Range about 1 mile east of Gunsight mine and 1½ miles north northwest of Noonday mine, northern part sec. 10, T. 20 N., R. 8 E.—Con.

Stirling Quartzite—Continued

C member:

	Feet
9. Siltstone and quartzite. Siltstone; grayish red (5*R* 4/2) with abundant greenish gray (5*GY* 6/1) and pale olive (10*Y* 6/2) in lower 50 ft; grades from fine-grained siltstone to sandy (very fine) coarse-grained siltstone; micaceous; laminated; platy splitting. Quartzite, grayish-red (5*R* 4/2) to pale-red-purple, minor pale-yellowish-brown (10*YR* 6/2) and greenish-gray (5*GY* 6/1); grades from silty very fine grained micaceous sandstone to fine- to medium-grained quartzite; evenly laminated; rare very small scale cross-laminae. Quartzite occurs in 1–24-in.-thick layers interstratified with siltstone. Quartzite constitutes about 10 percent of lower third of unit and increases in amount upward, although not consistently, to about 40 percent of top part of unit. Unit weathers to form steep slope; commonly covered with rubble	280
8. Siltstone, and minor dolomite and quartzite. Siltstone, grayish-olive (10*Y* 4/2), dusky-yellow (5*Y* 6/4), grayish-orange (10*YR* 7/4), and greenish-gray (5*GY* 6/1); fine to medium silt; some coarse silt; minor mica; platy splitting. Dolomite, pale-yellowish-brown (10*YR* 6/2); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline; commonly contains abundant very fine sand; laminated; occurs from 0 to 1 ft, 13 to 14 ft, and 23 to 24 ft above base of unit. Quartzite, yellowish-gray (5*Y* 8/1) to pale-yellowish-brown (10*YR* 6/2); very fine grained; laminated; 0.5–1-ft layers in top half of unit; constitutes about 30 percent of top half of unit. Unit weathers to form saddle	48
Total of C member	328

B member:

7. Quartzite to siltstone, and (5 percent) fine- to medium-grained quartzite in top 120 ft of unit. Quartzite to siltstone, grayish-purple (5*RP* 4/2) and grayish-red (5*R* 4/2); minor yellowish gray (5*Y* 8/1) in lower 40 ft; minor grayish purple (5*P* 4/2) in top half; grade from silty very fine grained, rarely fine grained, sandstone and quartzite to fine-grained siltstone; all gradations in rock type; evenly laminated; about half of rock quartzite and half siltstone. Fine- to medium-grained quartzite is mostly pinkish gray (5*YR* 8/1); laminated; and commonly contains very small scale cross-strata; occurs in 1–10-in. layers interstratified with the siltstone to quartzite. Basal 40 ft of unit is transitional into unit 6. A 6-in.-thick grayish-orange

Locality 26—Continued

Nopah Range section, measured in southern part of Nopah Range about 1 mile east of Gunsight mine and 1½ miles north northwest of Noonday mine, northern part sec. 10, T. 20 N., R. 8 E.—Con.

Stirling Quartzite—Continued

B member—Continued

	Feet
7. Quartzite to siltstone, etc.—Continued (10*YR* 7/4) evenly laminated limestone occurs 20 ft below top of unit. Top 20 ft of unit is siltstone to very fine grained silty sandstone that closely resemble rest of unit; this 20-ft layer, however, could be placed with overlying unit, which also contains some carbonate rock	220
Total of B member	220

NOTE.—Top 20 ft of unit 6 may also belong to B member.

A member:

6. Quartzite, yellowish-gray (5*Y* 8/1); mostly fine to medium grained in lower 175 ft; mostly fine to very fine grained from 175 to 260 ft, gradational in grain size between these two parts; minor granule conglomerate in lower 35 ft; mostly evenly laminated; common well-defined tabular planar sets (4–10 in. thick) of small-scale cross-strata. Unit forms whitish cliff. Basal 35 ft of unit is about half grayish red (5*R* 4/2) and is not greatly different from quartzite in units 4 and 5. A few light-greenish-gray (5*GY* 8/1) sandy micaceous siltstone layers about 2–4-in. thick occur in top 20 ft of unit	260
5. Quartzite (60 percent) and phyllitic siltstone (40 percent). Quartzite, pale-purple (5*P* 4/2) and yellowish-gray (5*Y* 8/1), mostly fine- to medium-grained, very thin bedded; some laminated parts. Phyllitic siltstone, grayish-purple (5*P* 4/2) to medium-dark-gray (*N*4); common mica; platy splitting; occurs as layers 1–6 ft thick interstratified with layers of quartzite 1–10 ft thick. Top of unit placed at top of highest phyllitic siltstone. Unit weathers to form minor saddle	95
4. Quartzite, yellowish-gray (5*Y* 8/1) and pinkish-gray (5*YR* 8/1), mostly fine- to coarse-grained; some (5 percent) very coarse grained and conglomeratic parts containing granules and small pebbles as large as ¼ in. in maximum diameter; thin bedded; some small- to medium-scale cross-laminae. Unit contains grayish-purple (5*P* 4/2) micaceous fine-grained quartzite from 42 to 43 ft above base, greenish-gray (5*GY* 6/1) micaceous sandy siltstone from 214 to 216 ft above base, and greenish-gray (5*GY* 6/1) micaceous fine-grained sandstone from 225 to 227 ft above base	328
3. Siltstone in lower 3 ft grading up into quartzite. Siltstone, grayish-red (5*R* 4/2); fine	

Locality 26—Continued

Nopah Range section, measured in southern part of Nopah Range about 1 mile east of Gunsight mine and 1½ miles north northwest of Noonday mine, northern part sec. 10, T. 20 N., R. 8 E.—Con.

Stirling Quartzite—Continued

A member—Continued

	Feet
3. Siltstone in lower 3 ft grading, etc.—Con. to medium silt; platy splitting. Quartzite, grayish-red (5*R* 4/2) to grayish-purple (5*P* 4/2), mostly fine- to medium-grained, laminated; some small-scale cross-strata	23
2. Quartzite and minor (10 percent) conglomeratic quartzite and conglomerate, yellowish-gray (5*Y* 8/1) and pinkish-gray (5*YR* 8/1), fine-grained to very coarse grained (conglomeratic quartzite and conglomerate contain pebbles of quarts and quartzite as large as 2 in. in maximum diameter); thin bedded; minor small- to medium-scale cross-strata	116
Total of A member	822
Total of Stirling Quartzite	2,334

Johnnie Formation:

1. Siltstone, greenish-gray (5*GY* 6/1); platy splitting; weathers to form slope	Unmeasured

SAN BERNARDINO COUNTY, CALIFORNIA

Locality 31

Winters Pass Hills section, measured about 5 miles northwest of Winters Pass in sec. 1, T. 19 N., R. 11 E. Section measured generally along ridge line of isolated hills (including hill 3826) about 2 miles northwest of main part of Mesquite Mountains

[Measured by J. H. Stewart, October 1964]

Wood Canyon Formation (incomplete):

Middle member:

	Feet
30. Quartzite, conglomeratic in part, grayish-green (10*GY* 5/2); weathers same color and dark yellowish brown (10*YR* 4/2); medium to very coarse grained, many parts containing granules and small pebbles, most of which are of white quartz but a few of which are of quartzite; sparse jasper pebbles; indistinctly very thin to thin bedded; common thin tabular planar or trough sets of cross-strata; weathers to form ledges. Only basal 200 ft of unit examined	Unmeasured

Lower member:

29. Quartzite to sandstone, light-greenish-gray (5*GY* 8/1) and grayish-yellow-green (5*GY* 7/2); fine-grained; micaceous in places; laminated to thin bedded; platy in part; weather to form slope	47
Total of lower member	47
Total of incomplete Wood Canyon Formation	47

Locality 31—Continued

Winters Pass Hills section, measured about 5 miles northwest of Winters Pass in sec. 1, T. 19 N., R. 11 E. Section measured generally along ridge line of isolated hills (including hill 3826) about 2 miles northwest of main part of Mesquite Mountains—Continued

	Feet
Stirling Quartzite:	
E member:	
28. Quartzite, with conglomerate in top 3 ft, yellowish-gray (5*Y* 8/1) and minor amount greenish-gray (5*GY* 6/1), fine- to medium-grained; very thin bedded; weathers to form minor light-colored ledge. Conglomerate contains granules and small pebbles that are mostly white chert, but a few that are quartzite	12
27. Silty quartzite, grayish-green (5*G* 5/2), fine- to medium-grained, very thin to thin-bedded; weathers to form slope	26
26. Quartzite, pinkish-gray (5*YR* 8/1) and very pale orange (10*YR* 8/2); weathers same colors; medium to coarse grained; laminated to thin bedded; about 50 percent is composed of very thin to thin tabular planar (rare trough) sets of high-angle cross-laminae; weathers to form prominent ridge. Conglomerate occurs from 265 to 275 ft above base of unit and in top 4 ft of unit; conglomerate contains granules and pebbles (as large as 2½ in. in maximum diameter) of white chert, pinkish quartzite, and sparse red jasper. A few layers in rest of unit contain a few granules and pebbles as large as 6 mm in maximum diameter. Unit from 315 to 318 ft above base composed of grayish-green (10*GY* 5/2) thin-bedded silty quartzite	322
Total of E member	360
D member:	
25. Quartzite (60 percent) and dolomitic sandstone (40 percent). Quartzite, yellowish-gray (5*Y* 8/1) to very pale orange (10*YR* 8/2), medium- to coarse-grained; evenly laminated in part and composed in part of very thin to thin tabular planar sets of cross-strata. Dolomitic sandstone, dark-yellowish-brown (10*YR* 4/2); weathers same color; medium to coarse grained; same stratification as quartzite; ½–2-ft layers interstratified with quartzite. Unit as a whole weathers to form ledgy slope	61
Total of D member	61

Offset on top of unit 24 so that unit 25 measured 500 ft northwest of unit 24.

	Feet
C member:	
24. Quartzite and minor siltstone. Quartzite, pale-olive (10*Y* 6/2) and yellowish-gray (5*Y* 7/2 and 5*Y* 8/1); weathers same colors and dark yellowish brown (10*YR* 4/2); grades from silty very fine grained quartzite to coarse-grained quartzite; a few layers containing granules and small pebbles (as large as about 6 mm); evenly laminated; some small-scale cross-strata in upper part. Siltstone, pale-olive (10*Y* 6/2); coarse silt; abundant very fine sand; common mica; interstratified with quartzite. Siltstone found only in lower third of unit, where it constitutes perhaps 20 percent of rock and decreases in amount upward. Unit shows a gradation from mostly fine-grained laminated quartzite and some siltstone in lower part to mostly medium- to coarse-grained quartzite (commonly cross-stratified) in upper part. Unit weathers to form slope with minor cliff in upper part. Unit is gradational into underlying unit	79
23. Siltstone and quartzite. Siltstone, grayish-red (10*R* 4/2 and 5*R* 4/2); fine to coarse silt; micaceous; platy. Quartzite, grayish-red (5*R* 4/2), minor amount yellowish-gray (5*Y* 8/1), fine-grained; evenly laminated ½-in. to 2-ft layers interstratified with siltstone. Siltstone constitutes about 50 percent of lower part of unit and decreases in amount upward to perhaps 30 percent at top	108
22. Phyllitic siltstone to silty sandstone, and minor quartzite. Phyllitic siltstone to silty sandstone, greenish-gray (5*GY* 6/1) and minor amount grayish-red (10*R* 4/2 and 5*R* 4/2) (grayish red occurs in part as mottles in greenish rock); grade from fine-grained phyllitic siltstone to very fine grained silty sandstone; commonly micaceous; platy. Quartzite, pinkish-gray (5*YR* 8/1), yellowish-gray (5*Y* 8/1), and light-greenish-gray (5*GY* 8/1); weathers same colors and pale yellowish brown (10*YR* 6/2); very fine to fine grained; laminated to very thin bedded; commonly wavy stratification; 1–12-in. layers interstratified with rest of unit. Quartzite constitutes about 15 percent of unit, except from 55 to 100 ft, where it constitutes about 30 percent. Unit as a whole weathers to form part of saddle in middle of Stirling Quartzite	122
Total of C member	309

Locality 31—Continued

Winters Pass Hills section, measured about 5 miles northwest of Winters Pass in sec. 1, T. 19 N., R. 11 E. Section measured generally along ridge line of isolated hills (including hill 3826) about 2 miles northwest of main part of Mesquite Mountains—Continued

Stirling Quartzite—Continued

B member: *Feet*

21. Quartzite, yellowish-gray (5*Y* 8/1) to greenish gray (5*GY* 6/1); weathers same colors and dark yellowish brown (10*YR* 4/2); predominantly very fine to fine grained; a few medium- to coarse-grained (a thin layer near base of unit contains very coarse grains to small pebbles (5 mm) of quartz); very fine to fine-grained part commonly micaceous; evenly laminated to indistinctly thin bedded; a few tabular planar sets and trough sets of small-scale low-angle cross-strata; weathers to form part of saddle in middle of Stirling Quartzite. About 20 percent of unit composed of thin resistant layers forming ledges between nonresistant layers. Resistant layers are very fine to fine grained or medium to coarse grained, the latter grain sizes found only in the resistant layers; cross-strata also are present only in the resistant layers ________ 88

Total of B member ________ 88

A member:

20. Quartzite, white (*N*9), yellowish-gray (5*Y* 8/1), and grayish-orange (10 *YR* 7/4); weathers very pale orange (10*YR* 8/2) to dark yellowish-brown (10*YR* 4/2); medium to coarse grained; in a few layers in top 30 ft of unit very coarse grains and granules as large as 4 mm; mostly evenly laminated to thin bedded; a few very low angle cross-strata and, in top 30 ft, some thin trough sets of high-angle cross-strata; weathers to form prominent ridge. A few layers of unit are friable sandstone that may be dolomitic ________ 160

Total A member ________ 160

Total of Stirling Quartzite ________ 978

Johnnie Formation:

Rainstorm Member:

Siltstone and quartzite unit:

19. Siltstone (60 percent) and quartzite (40 percent). Siltstone, greenish-gray (5*GY* 6/1), light-olive-gray (5*Y* 6/1), moderate-yellowish-brown (10*YR* 5/4), and rare grayish-red (5*R* 4/2); coarse silt; micaceous; platy. Quartzite, light-olive-gray (5*Y* 6/1) and pale-yellowish-brown (10*YR* 6/2); weathers pale yellowish brown (10 *YR* 6/2) to dark yellowish brown (10*YR* 4/2); very fine

Locality 31—Continued

Winters Pass Hills section, measured about 5 miles northwest of Winters Pass in sec. 1, T. 19 N., R. 11 E. Section measured generally along ridge line of isolated hills (including hill 3826) about 2 miles northwest of main part of Mesquite Mountains—Continued

Johnnie Formation—Continued

Rainstorm Member—Continued

Siltstone and quartzite unit—Continued

19. Siltstone (60 percent), etc.—Continued *Feet*
grained; micaceous in parts; evenly laminated ½-in. to 1-ft layers interstratified with siltstone. Unit as a whole weathers to form minor saddle on crest of hill. Unit gradational with underlying unit, and contact with underlying unit arbitrarily placed at top of highest dolomite layer ________ 37

Total of siltstone and quartzite unit ________ 37

Carbonate unit:

18. Dolomite (65 percent), silty dolomite (30 percent), and dolomitic sandstone (5 percent). Dolomite, very pale orange (10*YR* 8/2) to grayish-orange (10*YR* 7/4); weathers grayish orange (10*YR* 7/4) to light brown (5*YR* 6/4); very finely crystalline; evenly laminated; rare very low angle cross-strata. Silty dolomite; same as dolomite except contains minor amounts of coarse silt (very fine sand in some layers) and weathers dark yellowish brown (10*YR* 4/2). Dolomitic sandstone, pale-yellowish-brown (10*YR* 6/2); weathers dark yellowish brown (10*YR* 4/2); very fine grained; evenly laminated; a few very low angle cross-strata; apparently occurs only in bottom and top 20 ft of unit. Unit as a whole weathers to form ridge. Unit gradational into overlying and underlying units ________ 150

Total of carbonate unit ________ 150

Siltstone unit:

17. Phyllitic siltstone with 50 percent dolomitic(?) silty sandstone in top 20 ft. Phyllitic siltstone; grayish red (5*R* 4/2) in bottom 20 ft; mostly greenish gray (5*GY* 6/1) in top 20 ft; mostly fine silt; some coarse siltstone in upper half of unit; micaceous; platy. Some dolomitic siltstone in uppermost part of unit. Dolomitic(?) silty sandstone, light-olive-gray (5*GY* 6/1) to pale-yellowish-brown (10*YR* 6/2); weathers dark yellowish brown (10*YR* 4/2); very fine grained; grain size near boundary of silt and very fine sand; evenly laminated; platy; 1–12-in.

Locality 31—Continued

Winters Pass Hills section, measured about 5 miles northwest of Winters Pass in sec. 1, T. 19 N., R. 11 E. Section measured generally along ridge line of isolated hills (including hill 3826) about 2 miles northwest of main part of Mesquite Mountains—Continued

Johnnie Formation—Continued
Rainstorm Member—Continued
Siltstone unit—Continued

	Feet
17. Phyllitic siltstone, etc.—Continued layers interstratified with phyllitic siltstone. Unit as a whole weathers to form gentle slope	40
16. Oolitic dolomite (Johnnie oolite), very pale orange (10*YR* 8/2) to grayish-orange (10*YR* 7/4); weathers the latter color; composed of oolites 1–2 mm in diameter; indistinct laminae to thin beds; weathers to form prominent light-colored ledge	7
15. Phyllitic siltstone; moderate yellowish brown (10*YR* 5/4) in lower 19 ft; greenish gray (5*GY* 6/1), and small amount grayish red (5*R* 4/2), in top 19 ft; weathers same colors; fine silt; micaceous; platy; weathers to form gentle slope. A 6-in.-thick quartzite similar to that in unit 14 is 6 ft above base of unit. Basal 19 ft of unit contains a few very fine grained platy micaceous sandstone layers. Two 2–4-in. layers of brown-weathering silty (?) dolomite are in basal 4 ft of unit	38
Total of siltstone unit	85
Total of Rainstorm Member	272

Upper carbonate-bearing member:

	Feet
14. Quartzite, pale-yellowish-brown (10*YR* 6/2) and yellowish-gray (10*Y* 8/1); weathers dominantly pale yellowish brown (10*YR* 6/2); fine grained; some minor amounts medium- to coarse-grained layers; evenly laminated to thin bedded; weathers to form cliffy outcrop. A few very fine grained micaceous sandstone layers are interstratified with the quartzite	81
13. Dolomite, medium-light-gray (*N*6), minor amount pale-yellowish-brown (10*YR* 6/2); weathers moderate yellowish brown (10*YR* 5/4); aphanitic to very finely crystalline; indistinctly laminated to thin bedded; possibly some very low angle cross-strata; weathers to form minor ledge	7
12. Quartzite and 25 percent dolomite in top 70 ft of unit. Quartzite, light-olive-gray (10*Y* 6/1), and yellowish-gray (5*Y* 8/1) to very light gray (*N*8); weathers dominantly pale yellowish brown (10*YR* 6/2); very fine to fine grained; evenly laminated; some very low angle cross-strata. Dolomite, medium-light-gray (*N*6), light-olive-gray (5*Y* 6/1), and pale-yellowish-brown (10*YR* 6/2); weathers grayish orange (10*YR* 7/4); aphanitic to very finely crystalline; evenly laminated 1–12-in. layers interstratified with quartzite; found only in top 70 ft of unit. Unit as a whole weathers to form steep ledgy slope. Bottom 10 ft of unit is mostly covered and may be mostly siltstone or silty sandstone	125
11. Dolomite and a few irregular chert layers. Dolomite, medium-gray (*N*5) to pale-yellowish-brown (10*YR* 6/2); weathers grayish orange (10*YR* 7/4); aphanitic to very finely crystalline; evenly laminated to thin bedded. Chert, white (*N*9) to medium-light-gray (*N*6); cryptocrystalline quartz; indistinctly laminated 1-ft zone in middle of unit and locally as very thin to thin layers elsewhere in unit. Amount of chert variable in 1-ft zone, and individual layers within zone pinch and swell along outcrop and locally pinch out. Unit as a whole weathers to form minor ledge	15
Total of upper carbonate-bearing member	228

Offset on top of unit 10 so that unit 11 measured 300 ft northwest of unit 10.

Siltstone member:

	Feet
10. Sandstone (50 percent) and phyllitic siltstone (50 percent). Sandstone, moderate-yellowish-brown (10*YR* 5/4) to dark-yellowish-brown (10*YR* 4/2), and rare greenish-gray (5*GY* 6/1); weathers mostly dark yellowish brown (10*YR* 4/2); very fine grained; commonly micaceous; evenly laminated; rare very low angle cross-laminae; platy in places. Phyllitic siltstone, moderate-yellowish-brown (10*YR* 5/4), rare greenish-gray (5*GY* 6/1) and pale-red (10*R* 6/2); coarse silt; micaceous; commonly platy. Sandstone and siltstone are interstratified in layers 1 in. to 3 ft thick. Unit as a whole weathers to form slope. Unit contains two 1–2-ft layers of dolomite, one about 50 ft above base and the other about 20 ft below top of unit	198
9. Phyllitic sandy siltstone (50 percent) and silty sandstone (50 percent). Phyllitic sandy siltstone, light-gray (*N*7) and minor amount grayish-red (5*R* 4/2), grayish red commonly occurring as mottles and irregular patches; commonly contains very fine	

Locality 31—Continued

Winters Pass Hills section, measured about 5 miles northwest of Winters Pass in sec. 1, T. 19 N., R. 11 E. Section measured generally along ridge line of isolated hills (including hill 3826) about 2 miles northwest of main part of Mesquite Mountains—Continued

Johnnie Formation—Continued

Siltstone member—Continued

	Feet
9. Phyllitic sandy siltstone, etc.—Continued quartz(?) sand; white mica common. Silty sandstone, medium-gray (*N*5), and minor amount grayish-red (5*R* 4/2) and pale-yellowish-brown (10*YR* 6/2), very fine grained, commonly silty; micaceous in places; laminated. Rock types are gradational and interstratified in 1–10-in. layers. Unit as a whole weathers to form saddle	110
Total siltstone member	308

Lower carbonate-bearing member:

8. Dolomite to sandy dolomite and minor amount (10 percent) of dolomitic sandstone and quartzite. Dolomite to sandy dolomite, medium-light-gray (*N*6), olive-gray (5*Y* 4/1), and rare pale-yellowish-brown (10*YR* 6/2); weather dominantly moderate yellowish brown (10*YR* 5/4); laminated; most of dolomite is sandy; most of the sandy material is fine-grained quartz, although in a few layers medium to very coarse grains and granules of quartz occur. Quartzite and dolomitic sandstone; similar to those in underlying unit; thin tabular planar sets of small-scale cross-strata noted. The quartzite and dolomitic sandstone form 1-in. to 2-ft layers, some of which are lenticular, interstratified with the dolomite and sandy dolomite. Unit weathers to form east side of prominent ridge. A moderate-yellowish-brown (10*YR* 5/4) phyllite layer occurs from 76 to 77 ft above base of unit	85
Total of lower carbonate-bearing member	85

Quartzite member:

7. Quartzite, yellowish-gray (5*Y* 8/1) to very pale orange (10*YR* 8/2); weathers the latter color; fine to coarse grained; laminated to thin bedded; some waviness and irregularity to stratification; very rare tabular planar small-scale cross-strata; weathers to form prominent light-colored ridge along with unit 6. Unit from 40 to 45 ft above base and in top 23 ft contains a minor amount of dark-yellowish-brown (10*YR* 4/2) dolomite and sandy dolomite, and pale-yellowish-brown (10*Y* 6/2), dark-yellowish-brown (10*YR* 4/2)-weathering dolomitic sandstone. Quartzite in basal	

Locality 31—Continued

Winters Pass Hills section, measured about 5 miles northwest of Winters Pass in sec. 1, T. 19 N., R. 11 E. Section measured generally along ridge line of isolated hills (including hill 3826) about 2 miles northwest of main part of Mesquite Mountains—Continued

Johnnie Formation—Continued

Quartzite member—Continued

	Feet
7. Quartzite, yellowish-gray, etc.—Continued 20 ft contains a few layers of conglomeratic quartzite containing granules and small pebbles of white quartz	98
6. Quartzite and conglomerate, yellowish-gray (5*Y* 8/1), light-gray (*N*7), and rare pale-red (10*R* 6/2); weathers dominantly grayish red (10*R* 4/2) to dark yellowish brown (10*YR* 4/2); fine to coarse grained; indistinctly thin to very thin bedded; beds commonly slightly wavy; some thin tabular planar sets of cross-strata. Top 33 ft is conglomeratic with granules and pebbles of white quartz set in medium-grained to very coarse grained matrix; from 52 to 55 ft above base of unit is a conglomerate with pebbles (generally ½ in. in diameter) of white quartz. Unit as a whole forms prominent ridge along with unit 7	85
Total of quartzite member	183

Offset on top of unit 5 so that unit 6 measured 250 ft northwest of unit 5.

Transitional member:

5. Sandy dolomite to dolomite, and quartzite. Sandy dolomite to dolomite, medium-gray (*N*5) and minor amount pale-yellowish-brown (10*YR* 6/2); weather grayish orange (10*YR* 7/4); very finely crystalline to finely crystalline; have fine to coarse quartz grains in about three-fourths of the unit and granules and very coarse grains of quartz, gray quartzite(?), and chert(?) in some layers (the clastic grains constitute from a few percent to 50 percent of the rock and grade into dolomitic sandstone); indistinctly laminated to thick bedded; suggestion of very low angle cross-strata in places. Quartzite, light-gray (*N*7); weathers same color and brownish gray (5*YR* 4/1); fine-grained to very coarse grained; some conglomeratic layers containing granules and pebbles (as large as ½ in.) of white quartz and a few pebbles of gray quartzite(?) and chert(?); indistinctly laminated to thin-bedded layers and lenses 1 in. to 4 ft thick interstratified with the dolomite to sandy dolomite. Unit as a whole weathers to form hogback along line of section, but in most places forms steep slope along west side of hogback developed on unit 5. Unit from 0 to 35 ft is 50 percent quartzite and 50 percent sandy dolomite and from 35 to 170 ft is 15 percent quart-

Locality 31—Continued

Winters Pass Hills section, measured about 5 miles northwest of Winters Pass in sec. 1, T. 19 N., R. 11 E. Section measured generally along ridge line of isolated hills (including hill 3826) about 2 miles northwest of main part of Mesquite Mountains—Continued

Johnnie Formation—Continued

Transitional member—Continued

	Feet
5. Sandy dolomite, etc.—Continued zite and 85 percent sandy dolomite to dolomite. The quartzite and sandy dolomite layers are quite lenticular along outcrop; many of the thin quartzite layers appear to extend only 50 ft along the outcrop	170±
Total of transitional member	170±
Total of Johnnie Formation	1, 246

Noonday Dolomite:

4. Dolomite, pale-yellowish-brown (10*YR* 6/2) and rare medium-light-gray (*N*6); weathers pale yellowish brown (10*YR* 6/2); very finely crystalline to finely crystalline; evenly laminated; slightly wavy laminae in places; possibly some low-angle cross-strata; weathers to form ledgy outcrop. Unit contains a few silty and sandy dolomite laminae similar to those in underlying unit. Fifteen feet below top of unit is a lens of medium- to coarse-grained dolomitic sandstone	108
3. Dolomite (95 percent) and silty and sandy dolomite (5 percent). Dolomite, grayish-orange (10*YR* 7/4) to moderate-yellowish-brown (10*YR* 5/4); weathers same colors; very finely crystalline to finely crystalline; evenly laminated. Silty and sandy dolomite, moderate-yellowish-brown (10*YR* 5/4); weather same color; very finely crystalline to finely crystalline; contain 10–20 percent silt or very fine grained quartz(?) sand; evenly laminated ⅛–1-in. layers interstratified with dolomite. Unit weathers to form yellowish-brown slope between more massive lighter colored cliffy units above and below. Unit grades into overlying unit	25
2. Dolomite, very pale orange (10*YR* 8/2) to very light gray (*N*8); weathers very pale orange (10*YR* 8/2); very finely crystalline, some laminae are coarsely crystalline and probably recrystallized; mostly structureless in lower half and mostly indistinctly, but evenly, laminated in upper half; weathers to form prominent light-colored cliff. Unit cut by many small faults, and thickness of unit could be in error by as much as 50 ft	350±
Total of Noonday Dolomite	483±

NOTE.—Unconformable contact of granite and Noonday Dolomite is sharp. No fragments of granitic rock or of quartz or feldspar noted in dolomite at contact.

Locality 31—Continued

Winters Pass Hills section, measured about 5 miles northwest of Winters Pass in sec. 1, T. 19 N., R. 11 E. Section measured generally along ridge line of isolated hills (including hill 3826) about 2 miles northwest of main part of Mesquite Mountains—Continued

Older Precambrian rocks:	Feet
1. Granite to granitic gneiss, very pale orange (10*YR* 8/2); coarsely crystalline; composed of quartz and feldspar (probably mostly orthoclase) and sparse flakes of muscovite (some orthoclase phenocrysts are as large as 1 in. across); weathers to form gentle slope	Not measured

Base of section; base of exposure.

Locality 32

Winters Pass section, measured about ½ mile northwest of road and 1½ miles north-northeast of Winters Pass, central part of sec. 33, T. 19 N. R. 12 E.

[Measured by J. H. Stewart and S. D. Stewart, October 1964]

Latham Shale:	Feet
13. Siltstone, greenish-gray (5*GY* 6/1); mostly fine silt; some coarse silt; micaceous; platy splitting; weathers to form slope. About 100 ft of siltstone (Latham Shale) is present and contains some thin layers of carbonate in the upper part; this 100 ft of siltstone occurs below a prominent 30-ft *Girvanella*-bearing limestone (Chambless Limestone). Trilobites, including *Bristolia,* from middle of unit (USGS colln. 4638–CO, identified by A. R. Palmer, written commun., 1965)	Unmeasured

Zabriskie Quartzite (top contact uncertain):

12. Sandstone to quartzite, and minor(?) siltstone. Sandstone to quartzite, pale-yellowish-brown (10*YR* 6/2) and pinkish-gray (5*YR* 8/1); some fine-grained parts; some medium- to coarse-grained parts. Siltstone, pale-olive (10*Y* 6/2) to pale-yellowish-brown (10*YR* 6/2); fine to coarse silt. Unit is poorly exposed. It contains a few very thin quartzite layers similar to those in unit 11, but mostly it consists of a yellowish-gray possibly silty sandstone that is very poorly exposed. Unit as a whole weathers to form slope	11
11. Quartzite and minor siltstone. Quartzite, yellowish-gray (5*Y* 8/1) to light-gray (*N*7); fine-grained; laminated to very thin bedded; rare very low angle cross-strata. Siltstone occurs from 12 to 28 ft above base of unit, but is poorly exposed; exact amount and position not determinable. Unit from 12 to 15 ft above base contains several thin layers of limonite-rich, and possibly dolomitic, sandstone. Unit as a whole weathers to form slope with ledge at top and bottom	32
10. Siltstone, grayish-red (5*R* 4/2); coarse silt; micaceous; platy splitting; weathers to form slope	11
9. Quartzite; similar to unit 7; indistinctly thick bedded; abundant *Scolithus* tubes throughout	

Locality 32—Continued

Winters Pass section, measured about ½ mile northwest of road and 1½ miles north-northeast of Winters Pass, central part of sec. 33, T. 19 N., R. 12 E.—Continued

	Feet
Zabriskie Quartzite (top contact uncertain)—Con.	
9. Quartzite; similar to unit 7, etc.—Continued unit. A 1-ft yellow-gray fine-grained quartzite bed occurs about 2 ft above base of unit and similar quartzite occurs in top foot of unit. Unit weathers to form ledge	9
8. Siltstone, light-greenish-gray (5*GY* 8/1) to light-olive-gray (5*Y* 6/1); weathers same and pale yellowish-brown (10*YR* 6/2); fine silt; platy splitting; weathers to form slope. Parts of unit poorly exposed. Upper 2 ft of unit contains some yellowish-gray fine-grained quartzite transitional into unit 9	11
7. Quartzite, pinkish-gray (5*YR* 8/1), medium- to coarse-grained, thick-bedded; laminated to very thin bedded in lower foot; weathers to form ledge. Abundant *Scolithus* in all parts of unit except basal foot	11
Total of Zabriskie Quartzite (top contact uncertain)	85
Offset in section so that unit 7 measured about 1,000 ft east of unit 6. After offset unit 6 contains several dolomitic sandstone and dolomite units in top 6 ft.	
Wood Canyon Formation:	
Upper member:	
6. Quartzite, siltstone, and dolomite. Quartzite, pale-red (5*R* 6/2) to grayish-red (5*R* 4/2), and yellowish-gray (5*Y* 8/1); very fine grained; laminated. Siltstone, greenish-gray (5*GY* 6/1); fine silt; occurs as ¼–2-in. layers interstratified with quartzite. Dolomite, medium-gray (*N*5) to dark-yellowish-brown (10*YR* 4/2; weathers moderate yellowish brown (10*YR* 5/4) to dark yellowish brown (10*YR* 4/2); very finely crystalline; laminated to thin bedded; contains common to abundant pelmatozoa plates. Dolomite occurs in basal 8 ft and top foot of unit. Rest of unit is quartzite (80 percent) and siltstone (20 percent). Unit weathers to form slope; forms brownish outcrop below Zabriskie Quartzite	31
Offset in section so that unit 6 measured 200 ft northeast of unit 5.	
5. Quartzite (70 percent) and siltstone (30 percent). Quartzite, yellowish-gray (5*Y* 8/1) and rare greenish-gray (5*GY* 6/1), very fine grained, evenly laminated; sparse very low angle cross-strata; occurs in 1-in. to 10-ft layers interstratified with siltstone. Siltstone, greenish-gray (5*GY* 6/1) to grayish-yellowish-green (5*GY* 7/2); fine to coarse silt; commonly micaceous; platy splitting; occurs as 1-in. to 4-ft layers in-	

Locality 32—Continued

Winters Pass section, measured about ½ mile northwest of road and 1½ miles north-northeast of Winters Pass, central part of sec. 33, T. 19 N., R. 12 E.—Continued

	Feet
Wood Canyon Formation—Continued	
Upper member—Continued	
5. Quartzite (70 percent), etc.—Continued terstratified with quartzite. The quartzite is dolomitic and iron stained (limonite) in a few places. Trilobite spines occur very rarely in top 180 ft of unit. *Scolithus* occurs about 50 ft below top of unit. A few thin beds of pale-yellowish-brown (10*YR* 6/2), light-brown (5*YR* 5/6), or light-olive-gray (5Y 6/1) very finely crystalline dolomite occur in unit. These dolomite layers occur in the following positions: two thin layers in interval approximately 219–225 ft above base of unit, a 5-in. layer approximately 314 ft above base of unit, and a 5-in. layer 12 ft below top of unit. An iron-rich grayish-red very fine grained quartzite with some micro-cross-strata (ripples?) occurs from 90 to 103 ft above base of unit. Unit weathers to form a slope with a prominent ledgy and ridge-forming interval from 69 to 103 ft above base. Top 100 ft of unit highly contorted by folds; therefore the thickness of the unit cannot be accurately measured. Thickness of unit could be in error by 100 ft	400(?)
4. Siltstone to silty sandstone, and minor quartzite. Siltstone to silty sandstone, light-olive-gray (5*Y* 5/2) to dusky-yellow (5*Y* 6/4); grade from fine-grained siltstone to silty very fine grained sandstone; micaceous; laminated in part; structureless in part; platy splitting in some parts. A quartzite, locally containing scattered granules of quartz, occurs from 48 to 56 ft above base of unit; this quartzite is similar to that in unit 3 and might be a tongue of unit 3. The top 24 ft of unit contains yellowish-gray (5*Y* 8/1) to pale-yellowish-brown (10*YR* 6/2) very fine grained laminated quartzite; this quartzite constitutes about 30 percent of this part of the unit and is transitional into unit 5. Unit as a whole weathers to form saddle with minor ledge on quartzite from 48 to 56 ft above base of unit. Top of unit placed at highest occurrence of light-olive-gray siltstone or silty sandstone	163
Total of upper member	594±
Middle member:	
3. Quartzite (80 percent) and phyllitic siltstone to silty sandstone (20 percent).	

Locality 32—Continued

Winters Pass section, measured about ½ mile northwest of road and 1½ miles north-northeast of Winters Pass, central part of sec. 33, T. 19 N., R. 12 E.—Continued

Wood Canyon Formation—Continued

Middle member—Continued

	Feet
3. Quartzite (80 percent), etc.—Continued Quartzite, yellowish-gray (5*Y* 8/1), very pale orange (10*YR* 8/2), and light-brownish-gray (5*Y* 6/1); weathers brownish-gray (5*YR* 4/1) and dark yellowish brown (10*YR* 4/2); fine to medium grained; rare coarse-grained parts, a few layers contain scattered granules; composed of tabular planar sets of small-scale cross-strata; some very thin to thin beds. Phyllitic siltstone to silty sandstone, grayish-red (5*R* 4/2) and rare greenish-gray (5*GY* 6/1); micaceous fine-grained siltstone to micaceous silty very fine grained sandstone; commonly platy splitting; occur as 1-in. to 4-ft layers interstratified with quartzite. Unit as a whole weathers to form ridge. Quartzite commonly contains flat grayish-red (5*R* 4/2) siltstone fragments about ½–1 in. in diameter	672
2. Quartzite and minor (10 percent) conglomerate, yellowish-gray (5*Y* 8/1) to pale-yellowish-brown (10*YR* 6/2); medium-grained to very coarse grained, (conglomerate contains granules and pebbles of quartz, and rarely of quartzite, as large as 0.7 in. in maximum diameter); composed of thin tabular planar sets of small- to medium-scale cross-strata; some very thin to thin beds; weathers to form ledgy slope. A few thin layers of greenish-gray (5*GY* 6/1) micaceous fine-grained sandstone occur in unit	412
Total middle member	1,084
Total Wood Canyon Formation	1,678

NOTE.—Contact between Wood Canyon Formation and Stirling Quartzite placed at change from dense vitreous light-colored quartzite to less quartzitic darker colored quartzite. Top part of Stirling forms well-defined cliff, whereas Wood Canyon Formation forms ledgy slope. No silty rock noted between Stirling and Wood Canyon.

Stirling Quartzite:

1. Quartzite, yellowish-gray (5*Y* 8/1) to very pale orange (10*YR* 8/2); medium to coarse grained; some conglomerate with pebbles as large as 1.2 in., pebbles mostly white quartz; very thin to thin bedded; in over half of unit, is composed of thin tabular planar sets of small-scale cross-strata; weathers to form cliff	Unmeasured

Locality 33

Salt Spring Hills No. 1 section, measured about 1–2 miles east of U.S. Highway 127 and 2 miles northeast of Salt Creek, northernmost part of secs. 17 and 18 (unsurveyed), T. 18 N., R. 7 E.

[Measured by J. H. Stewart, November 1964]

Top of section, top of exposure.

Chambless limestone (incomplete):

	Feet
30. Limestone, medium-gray (*N*5) and pale-red (5*R* 6/2); weathers light olive gray (5*Y* 6/1); finely crystalline; indistinctly very thin bedded; weathers to form ledge and underlies dip slope at highest outcrops. *Girvanella* common	30±
Total of incomplete Chambless Limestone	30±

Latham Shale:

29. Siltstone and minor amount of limestone in top 75 ft. Siltstone, greenish-gray (5*GY* 6/1); minor amount light-brownish-gray (5*YR* 6/1) in bottom 35 ft; fine silt; micaceous; platy. Limestone, light-olive-gray (5*Y* 6/1), medium-dark-gray (*N*4), and pale-yellowish-brown (10*YR* 6/2); weathers moderate yellowish brown (10 *YR* 5/4); finely to medium crystalline; indistinctly laminated to thin bedded; grades to limy siltstone in places. Unit as a whole weathers to form slope. *Girvanella* occur in a limestone bed from 62 to 65 ft above base of unit. Prominent interval with 50 percent limestone occurs from 62 to 76 ft above base. Trilobites (USGS collection 4640–CO) are found approximately 15–20 ft above base of unit (*Paedeumias clarki* Resser, *Olenellus* sp., and *Bristolia*? sp., USGS colln. 4640–CO, identified by A. R. Palmer, written commun., 1965)	110
28. Quartzite (50 percent) and siltstone (50 percent). Quartzite, grayish-red (5*R* 4/2) and minor amount yellowish-gray (5*Y* 8/1), fine-grained; fine to medium grained in top 3 ft; laminated; rare low-angle cross-strata. Siltstone; similar to that in unit 27. Unit as a whole weathers to form ledge	13
27. Siltstone and minor amount of quartzite. Siltstone, greenish-gray (5*GY* 6/1) and grayish-red (5*R* 4/2); fine to coarse silt; micaceous; platy. Quartzite, olive-gray (5*Y* 4/1); very fine grained; laminated 1–6-in. layers. Unit as a whole weathers to form minor ledge	8
26. Quartzite, yellowish-gray (5*Y* 8/1), pinkish-gray (5*YR* 8/1), medium-light-gray (*N*6), and grayish-red (5*R* 4/2); weathers brownish black (5*YR* 2/1); fine grained; some fine- to medium-grained parts; laminated; rare very low angle cross-strata; weathers to form minor ledge	11
25. Siltstone, grayish-red (5*R* 4/2); greenish-gray (5*GY* 6/1) in basal 2 ft; medium to coarse silt; micaceous; platy; weathers to form slope	9
Total of Latham Shale	151

Locality 33—Continued

Salt Spring Hills No. 1 section, measured about 1–2 miles east of U.S. Highway 127 and 2 miles northeast of Salt Creek, northernmost part of secs. 17 and 18 (unsurveyed), T. 18 N., R. 7 E.—Con.

Offset in section so that unit 25 measured 300 ft southwest of the place where unit 24 measured.

Zabriskie Quartzite:	*Feet*
24. Quartzite; sequence of colors is as follows: 0–13 ft, grayish-red (5*R* 4/2); 13–17 ft, pale yellowish brown (10*YR* 6/2); 17–26 ft, light gray (*N*7) to light greenish gray (5*GY* 8/1); and 26–48 ft, very pale orange (10*YR* 8/2) and grayish red (5*R* 4/2). Quartzite is fine to medium grained, has some coarse grains, is laminated and indistinctly thin bedded; weathers to form dip slope. Abundant *Scolithus* tubes from 23 to 24 ft and 44 to 48 ft above base of unit	48
23. Quartzite, pinkish-gray (5*YR* 8/1) to yellowish-gray (5*Y* 8/1); weathers very pale orange (10*YR* 8/2) to pale yellowish brown (10*YR* 6/2); fine to medium grained; scattered coarse and very coarse grains and very rare granules of quartz; indistinct stratification, which appears to be laminated to very thin bedded; common very low angle small-scale cross-strata; weathers to form prominent cliff. Basal 40 ft contains minor amounts of fine-grained quartzite that weathers dark yellowish brown (10*YR* 4/2)	112
22. Quartzite (90 percent) and siltstone to silty sandstone (10 percent). Quartzite, pale-yellowish-brown (10*YR* 6/2), yellowish-gray (5*Y* 8/1), and minor amount pinkish-gray (5*YR* 8/1); fine to medium grained; rare coarse grains; laminated; rare low-angle small-scale cross-laminae. Siltstone to silty sandstone, grayish-red (5*R* 4/2) and greenish-gray (5*GY* 6/1); coarse silt to very fine grained sand; sparse mica; laminated; platy; 0.5–2-ft layers interstratified with quartzite. Basal 4 ft of unit is quartzite that contains abundant *Scolithus* tubes. Top of unit placed at top of highest silty layer	27
Total of Zabriskie Quartzite	187

Wood Canyon Formation:
Upper member:

21. Quartzite, pale-yellowish-brown (10*YR* 6/2) to very pale orange (10*YR* 8/2); very fine to fine grained; laminated; rare low-angle cross-strata; weathers to form cliffy unit continuous with units 22 and 23. This unit is part of transition between Wood Canyon Formation and Zabriskie Quartzite. It is placed in Wood Canyon Formation because of its fine grain size	28

Offset in section so that unit 21 measured 200 ft south of unit 20.

Locality 33—Continued

Salt Spring Hills No. 1 section, measured about 1–2 miles east of U.S. Highway 127 and 2 miles northeast of Salt Creek, northernmost part of secs. 17 and 18 (unsurveyed), T. 18 N., R. 7 E.—Con.

Wood Canyon Formation—Continued
Upper member—Continued

	Feet
20. Siltstone to silty sandstone (85 percent) and quartzite (15 percent). Siltstone to silty sandstone, greenish-gray (5GY 6/1) to light-olive-gray (5*Y* 6/1); grade from fine siltstone to silty very fine grained sandstone, but are mostly coarse silt and very fine grained sand; micaceous; indistinctly bedded, some parts appear structureless. Quartzite, pale-yellowish-brown (10*YR* 6/2) and brownish-gray (5*YR* 4/1); very fine grained; laminated ¼–8-in. layers interstratified with rest of unit. Unit as a whole weathers to form gentle slope	62
19. Dolomite (60 percent), quartzite to dolomitic sandstone (30 percent), and siltstone (10 percent). Dolomite, olive-gray (5*Y* 4/1), grayish-red (5*R* 4/2), medium-gray (*N*5), and pale-yellowish-brown (10*YR* 6/2); weathers moderate yellowish brown (10*YR* 5/4); Medium to coarsely crystalline; some slightly limy parts; commonly contains pelmatozoan debris; irregularly laminated to thin bedded; rare low-angle cross-strata; commonly sandy (very fine) and grades to dolomitic sandstone. Quartzite to dolomitic sandstone, pale-yellowish-brown (10*YR* 6/2), medium-gray (N5), and grayish-red (5*R* 4/2); very fine grained; laminated; commonly dolomitic and grade to sandy dolomite. Siltstone, greenish-gray (5*GY* 6/1); coarse silt; micaceous; 1–6-in. layers interstratified with quartzite. Unit as a whole weathers to form ledgy slope	113
18. Quartzite (60 percent) and siltstone (40 percent). Quartzite, olive-gray (5*Y* 4/1), brownish-gray (5*YR* 4/1), and medium-dark-gray (*N*4); weathers brownish black (5*YR* 2/1); mostly very fine grained, rarely fine grained; evenly laminated; sparse small-scale cross-strata; stratification planes commonly covered with tracks, trails, scratches, and burrows. In places, molds of possible small brachiopods are found in the quartzite. Siltstone, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1) and medium-dark-gray (*N*4); coarse silt; micaceous; platy; 1-in. to 3-ft layers interstratified with quartzite. Unit as a whole weathers to form slope. Unit contains pale-yellowish-brown (10*YR* 6/2), moderate-yellowish-brown (10*YR* 5/4)-weathering limy dolomite from 82.0 to 82.2 ft and 103.0 to 104.0 ft above base of unit	130
17. Quartzite and minor amount (20 percent) of siltstone in top half. Quartzite, olive-gray (5*Y* 4/1) and pale-red (5*R* 6/2), colors commonly interlayered; weathers brownish gray (5*YR* 4/1); mostly very fine grained,	

Locality 33—Continued

Salt Spring Hills No. 1 section, measured about 1–2 miles east of U.S. Highway 127 and 2 miles northeast of Salt Creek, northernmost part of secs. 17 and 18 (unsurveyed), T. 18 N., R. 7 E.—Con.

Wood Canyon Formation—Continued

Upper member—Continued

	Feet
17. Quartzite and minor amount, etc.—Continued rarely fine grained; evenly laminated; sparse small-scale low-angle cross-strata. Siltstone, medium-dark-gray (*N*4) to dark-greenish-gray (5*GY* 4/1); coarse silt; micaceous; platy; 1–10-in. layers interstratified with quartzite in top half of unit. Unit as a whole weathers to form prominent ledge. Unit grades into overlying unit, but can be separated from it mainly because there is less siltstone and because unit, unlike the overlying unit, weathers to form a ledge	50
Offset in section so that unit 17 measured 1,500 ft east of the place where unit 16 measured.	
16. Fine-grained siltstone (50 percent) and coarse-grained siltstone to very fine grained silty quartzite (50 percent). Fine-grained siltstone, dark-greenish-gray (5*GY* 4/1); somewhat micaceous; platy. Coarse-grained siltstone to very fine grained silty quartzite, olive-gray (5*Y* 4/1) to dark-greenish-gray (5*GY* 4/1); grade from coarse siltstone to very fine grained silty quartzite; micaceous; evenly laminated ¼-in. to 2-ft layers interstratified with siltstone layers of similar thicknesses. Unit as a whole weathers to form slope. A few microripples and indistinct markings noted on quartzite bedding surfaces. Top of unit at highest occurrence of fine-grained siltstone. Overlying strata are cliff-forming very fine grained quartzite; basal 10 ft of this overlying quartzite somewhat less resistant	174
Total of upper member	557

Middle member:

	Feet
15. Quartzite and minor (20 percent) siltstone. Quartzite, yellowish-gray (5*Y* 8/1), greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1), and medium-dark-gray (*N*4); weathers brownish black (5*YR* 2/1); dominantly fine to medium grained; some fine-grained parts; conglomeratic parts in lower 50 ft of unit, granules of quartz; in places contains pellets of siltstone; composed of trough and a few tabular planar sets of cross-strata; a few laminated to thin-bedded parts; siltstone, grayish-red (5*R* 4/2) to medium-dark-gray (*N*4), commonly dark-greenish-gray (5*GY* 4/1) in top 100 ft; fine to coarse silt; micaceous; platy; 1-in. to 6-ft layers interstratified with quartzite; siltstone appears to be more abundant in top 100 ft of unit, where it may constitute about 40 percent of strata. Unit as a whole weathers	

Locality 33—Continued

Salt Spring Hills No. 1 section, measured about 1–2 miles east of U.S. Highway 127 and 2 miles northeast of Salt Creek, northernmost part of secs. 17 and 18 (unsurveyed), T. 18 N., R. 7 E.—Con.

Wood Canyon Formation—Continued

Middle member—Continued

	Feet
15. Quartzite and minor, etc.—Continued to form cliff. Some small faults, probably with displacements of 5 or 10 ft, crossed along line of section; thickness of unit probably accurate within about 50 ft, however	535±
14. Sandstone and minor amount (5 percent) of conglomerate, pale-red (5*R* 6/2) and (10*R* 6/2) minor amount dark-greenish-gray (5*GY* 4/1); weather dark yellowish brown (10*YR* 4/2); medium grained to very coarse grained, the conglomerate composed of granules and small pebbles (as large as 28 mm in maximum diameter) that are mostly quartz (quartzite and jasper pebbles are sparse); composed of very thin to thin tabular planar and trough sets of low- and high-angle cross-strata; a few very thin bedded parts; weather to form cliff; grade into overlying unit. Unit contains a few thin layers of medium-gray (*N*5) fine- to coarse-grained micaceous siltstone	185
Total of middle member	720

Lower member:

	Feet
13. Quartzite (70 percent) and siltstone (30 percent). Quartzite, pale-red (5*R* 6/2), light-olive-gray (5*Y* 6/1), medium-gray (*N*5), and yellowish-gray (5*Y* 8/1); very fine to fine grained; micaceous; laminated; platy to flaggy. Siltstone, greenish-gray (5*GY* 6/1) to medium-gray (*N*5); grayish red (5*R* 4/2) in top 5 ft; coarse silt; micaceous; platy. Unit as a whole weathers to form slope. Top 1 ft of unit is pale-reddish-brown (10*R* 5/4), dark-yellowish-brown (10*YR* 4/2)-weathering hematite-rich fine-grained sandstone. Weathered color indicates that sandstone is probably dolomitic	43
Total of lower member	43
Total of Wood Canyon Formation	1, 320

Offset in section so that unit 13 measured 1,000 ft north of unit 12.

Stirling Quartzite:

E member:

12. Quartzite, pinkish-gray (5*YR* 8/1); weathers pale yellowish brown (5*YR* 6/2); medium to coarse grained; indistinctly bedded; weathers to form ledge. Top 4 ft is mostly granule conglomerate containing granules of quartz. About 1 ft below top of unit is very thin layer of greenish-gray coarse silt-

Locality 33—Continued

Salt Spring Hills No. 1 section, measured about 1–2 miles east of U.S. Highway 127 and 2 miles northeast of Salt Creek, northernmost part of secs. 17 and 18 (unsurveyed), T. 18 N., R. 7 E.—Con.

Stirling Quartzite—Continued

E member—Continued

	Feet
12. Quartzite, pinkish-gray, etc.—Continued stone overlain by olive-gray (5*Y* 4/1) dolomitic sandstone. A few small pebbles (the largest is 0.4 in. in diameter) occur in top 4 ft of unit	11
11. Phyllitic siltstone and quartzite. Phyllitic siltstone, greenish-gray (5*GY* 6/1); coarse silt; commonly contains very fine sand; micaceous; platy. Quartzite, yellowish-gray (5*Y* 8/1) to light-olive-gray (5*Y* 6/1); fine to medium grained; laminated to thin bedded; forms a few thin layers in lower 11 ft of unit and constitutes the entire top 4 ft of the unit. Unit weathers to form slope	15
10. Conglomerate and quartzite, yellowish-gray (5*Y* 8/1) to pinkish-gray (5*YR* 8/1); weather pale yellowish brown (10*YR* 6/2); coarse-grained quartzite and conglomerate containing granules and pebbles (as large as 1.0 in.) of quartz (rarely jasper); indistinctly thin bedded; rare low-angle cross-strata; weather to form ledge	5
9. Quartzite, yellowish-gray (5*Y* 8/1); weathers dusky yellowish brown (10*YR* 2/2); fine grained; laminated; weathers to form minor reentrant in cliff	3
8. Quartzite, yellowish-gray (5*Y* 8/1) to pinkish-gray (5*YR* 8/1); medium to coarse grained; some very coarse grains in parts; laminated to thin bedded; a few thin tabular planar sets of cross-strata; weathers to form cliff. Unit from 176 to 180 ft is conglomerate that contains granules and pebbles (as large as 1.9 in. in maximum diameter) of quartz and scarce jasper. Granule conglomerate or conglomeratic quartzite is found in a few places from 180 to 210 ft above base of unit	236
Total of E member	270

D(?) member:

	Feet
7. Quartzite (60 percent) and hematitic sandstone (40 percent). Quartzite, yellowish-gray (5*Y* 8/1) to very light gray (*N*8); grades from fine grained to coarse grained; laminated; a few thin tabular planar sets of small-scale high-angle cross-strata. Hematitic sandstone, pale-reddish-brown (10*R* 5/4) to grayish-red (5*R* 6/2); medium to coarse grained; laminated; a few cross-strata; 0.5-in. to 2-ft layers interstratified with quartzite. Some of the hematitic sandstone may be dolomitic, but most of it probably is not, except for a few thin layers in the lower 2 ft of the unit that are denser and weather dark yellowish brown (10*YR* 4/2). Unit weathers to form slope	90
Total of D(?) member	99

C member:

	Feet
6. Siltstone and quartzite. Siltstone, medium-gray (*N*5) to dark-greenish-gray (5*GY* 4/1); medium to coarse silt; commonly contains very fine grained sand; micaceous; platy. Quartzite, medium-light-gray (*N*6) to medium-gray (*N*5) and light-olive-gray (5*Y* 6/1); weathers same colors and dark-greenish-gray (5*GY* 4/1); very fine to fine grained, commonly silty; commonly contains pellets of siltstone; evenly laminated ¼-in. to 1-ft layers interstratified with siltstone. Unit as a whole weathers to form ledgy slope. Top 20 ft of unit contains about 20 percent light-gray (*N*7) to light-greenish-gray (5*GY* 8/1) medium- to coarse-grained laminated and cross-stratified quartzite in layers from 1–12 in. thick. Amount of quartzite generally increases upward in unit. Sequence in unit is: 0–20 ft, 50 percent quartzite; 20–145 ft, about 20 percent quartzite near base increasing gradually to about 40 percent near top; 145–167 ft, 50 percent quartzite; and 167–187 ft, 75 percent quartzite including medium- to coarse-grained quartzite	187
Offset in section so that unit 6 measured starting 200 ft northeast of place where unit 5 measured.	
5. Quartzite (90 percent) and siltstone (10 percent). Quartzite, dark-greenish-gray (5*GY* 4/1), pinkish-gray (5*YR* 8/1), and yellowish-gray (5*Y* 8/1); weathers pale yellowish brown (10*YR* 6/1) to light brown (5*YR* 6/4); fined grained; minor amount fine to medium grained; laminated; laminae slightly irregular, possibly ripple laminae in places. Siltstone, similar to that in unit 4, except tends to be mostly sandy (very fine); 1–6-in. layers interstratified with quartzite. Unit weathers to forms ledge, somewhat light colored, in dominantly silty and slope-forming sequence	12
4. Siltstone (90 percent) and quartzite (10 percent). Siltstone, dark-greenish-gray (5*GY* 4/1); coarse silt; commonly sandy (very fine); micaceous; platy. Quartzite, dark-greenish-gray (5*GY* 4/1), rare greenish-gray (5*GY* 6/1) and yellowish-gray (5*Y* 8/1), very fine grained; laminated ¼–12-in. layers interstratified with siltstone.	

Locality 33—Continued

Salt Spring Hills No. 1 section, measured about 1–2 miles east of U.S. Highway 127 and 2 miles northeast of Salt Creek, northernmost part of secs. 17 and 18 (unsurveyed), T. 18 N., R. 7 E.—Con.

Stirling Quartzite—Continued
C member—Continued

	Feet
4. Siltstone (90 percent), etc.—Continued Unit as a whole weathers to form slope. Top 2 ft of unit contains several lenticular layers (¼–2 in. thick) of light-olive-gray (5*Y* 6/1) to dusky-yellow (5*Y* 6/4) moderate-yellowish-brown (10*YR* 5/4)-weathering limestone that is commonly silty. Unit 4 measured again about 1,000 ft to north. At this locality, the unit is 50 ft thick, and dolomitic limestone layers are found at 26.5–27.0 ft and 45.5–46.0 ft above base of unit. These limestone layers are apparently discontinuous	47
Total of C member	246

B(?) member:

3. Quartzite and minor amount of siltstone in top 35 ft. Quartzite, yellowish-gray (5*Y* 8/1), pinkish-gray (5*YR* 8/1), pale-red (5*R* 6/2), and light-greenish-gray (5*GY* 8/1) to greenish-gray (5*GY* 6/1); weathers dominantly dark yellowish brown (10*YR* 4/2) to pale yellowish brown (10*YR* 6/2); grades from very fine grained to coarse grained (medium- to coarse-grained parts found in laminae or thin beds interstratified with finer grained strata; medium to coarse grains in places are in very fine grained matrix); laminated to very thin bedded. Ripple-marked surface on quartzite 1 ft below top of unit; this surface also contains casts of mud cracks. Siltstone, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1); coarse silt; very fine sand common; micaceous; platy; 1–6-in. layers in top 35 ft of unit; increases in amount upward from about 10 percent to about 30 percent. Unit as a whole weathers to form cliff. Gradational into overlying and underlying units	85
Total of B(?) member	85

A member:

2. Quartzite, yellowish-gray (5*Y* 8/1) to pinkish-gray (5*YR* 8/1); weathers pale yellowish brown (10*YR* 6/2) to dusky yellowish brown (10*YR* 2/2); medium to coarse grained; laminated to very thin bedded; a few (20 percent) very thin to thick tabular planar sets of high- and low-angle cross-strata in top 90 ft; weathers to form cliff. Top 6 in. of unit contains scattered granules

Locality 33—Continued

Salt Spring Hills No. 1 section, measured about 1–2 miles east of U.S. Highway 127 and 2 miles northeast of Salt Creek, northernmost part of secs. 17 and 18 (unsurveyed), T. 18 N., R. 7 E.—Con.

Stirling Quartzite—Continued
A member—Continued

	Feet
2. Quartzite, yellowish-gray, etc.—Continued and pebbles (as large as 10 mm in maximum diameter) of quartz	150
Total of A member	150
Total of Stirling Quartzite	841

Johnnie Formation:
Rainstorm Member:

1. Quartzite and dolomite. Quartzite, pale-red (5*R* 6/2); weathers dusky yellowish brown (10*YR* 2/2); fine grained; evenly laminated to very thin bedded; platy to flaggy splitting. Dolomite, grayish-orange-pink (5*YR* 7/2) to pale-yellowish-brown (10*YR* 6/2); weathers moderate yellowish brown (10*YR* 5/4); very finely to finely crystalline; some suggestion of oolites in a few layers; indistinctly very thin to thin-bedded 1-in. to 2-ft layers interstratified with quartzite. About 100 ft of unit exposed. Highest dolomite is 18 ft below top of unit. Dolomite constitutes about 80 percent of strata. Unit as a whole weathers to form ledgy slope	Unmeasured

Locality 34

Salt Spring Hills No. 2 section, measured in southernmost part of Salt Spring Hills about 2 miles south-southwest of U.S. 127, southwestern part sec. 6 (unsurveyed), T. 17 N., R. 7 E.

[Measured by J. H. Stewart, November 1964]

Stirling Quartzite:

14. Quartzite, yellowish-gray (5*Y* 8/1); weathers pale yellowish brown (10*YR* 6/2); fine to medium grained; minor amount medium to coarse grained; bedding largely obscure, some thin bedding; weathers to form cliff. Only basal 10 ft examined	Unmeasured

Johnnie Formation:
Rainstorm Member:
Carbonate unit: *Feet*

13. Quartzite to dolomitic quartzite (70 percent) and dolomite (30 percent). Quartzite to dolomitic quartzite, pale-yellowish-brown (10*YR* 6/2), minor amount olive-gray (5*Y* 4/1) and medium-dark-gray (*N*4); weather dominantly pale yellowish brown (10*YR* 6/2) to dark yellowish brown (10*YR* 4/2); very fine grained; micaceous in places; indistinctly laminated to thin bedded. Some of the medium-dark-gray

Locality 34—Continued

Salt Spring Hills No. 2 section, measured in southernmost part of Salt Spring Hills about 2 miles south-southwest of U.S. 127, southwestern part sec. 6 (unsurveyed), T. 17 N., R. 7 E.—Con.

Johnnie Formation—Continued
Rainstorm Member—Continued
Carbonate unit—Continued

	Feet
13. Quartzite to dolomitic quartzite, etc.—Con. (*N*4) quartzite grades to micaceous sandy (very fine) coarse-grained siltstone. Dolomite, pale-yellowish-brown (10*YR* 6/2) and medium-gray (*N*5); weathers grayish orange (10*YR* 7/4); very finely crystalline; laminated to very thin bedded 0.5–2-ft layers interstratified and intergrading with quartzite and dolomitic quartzite. Dolomite constitutes about 60 percent of lower 13 ft of unit and 90 percent of upper 20 ft of unit. Elsewhere it occurs only in a few thin layers. Unit as a whole weathers to form slope	75
Total of carbonate unit	75

Siltstone unit:

12. Siltstone to quartzite, dark-greenish-gray (5*GY* 4/1); coarse siltstone to silty very fine grained quartzite; evenly laminated; platy to blocky; weather to form ledgy slope. Unit becomes more sandy and more quartzitic upward	48
11. Siltstone, moderate-yellowish-brown (10*YR* 5/4), rare moderate-red (5*R* 5/4); medium to coarse silt; some mica; platy; weathers to form slope	18
10. Dolomite (Johnnie oolite), grayish-orange (10*YR* 7/4); weathers same color; composed of round oolites about 1 mm across; indistinctly thin bedded; weathers to form prominent light-colored ledge	6
Total of siltstone unit (includes top 15 ft of unit 9)	87
Total of Rainstorm Member (includes top 15 ft of unit 9)	162

Upper carbonate-bearing member:

9. Siltstone and minor amounts of dolomite and quartzite. Siltstone, light-greenish-gray (5*GY* 8/1), pale-yellowish-brown (10*YR* 6/2), and rare pale-red (10*R* 6/2); fine to coarse silt; micaceous; platy. Dolomite similar to that in unit 8 occurs from 0 to 1 ft and 14.0 to 14.5 ft above base of unit. Quartzite, pale-yellowish-brown (10*YR* 6/2), very fine grained; some mica; laminated ¼–3-in. layers in interval from 10 to 17 ft above base of unit; constitutes about 20 percent of this interval. Interval from 10 to 17 ft also contains some dolomitic siltstone. Unit as a whole weathers to form slope	32

Locality 34—Continued

Salt Spring Hills No. 2 section, measured in southernmost part of Salt Spring Hills about 2 miles south-southwest of U.S. 127, southwestern part sec. 6 (unsurveyed), T. 17 N., R. 7 E.—Con.

Johnnie Formation—Continued
Upper carbonate-bearing member—Continued

	Feet
8. Quartzite and sparse (10 percent) siltstone. Quartzite, pale-red (10*R* 6/2), pinkish-gray (5*YR* 8/1), and yellowish-gray (5*Y* 8/1); weathers dark yellowish brown (10*YR* 4/2) with reddish cast; very fine to fine grained; very rare medium- to coarse-grained parts; indistinctly laminated to thin bedded. Siltstone, yellowish-gray (5*Y* 8/1) to pale-yellowish-brown (10*YR* 6/2); coarse silt; micaceous; platy; found in bottom 5 ft of unit and rarely elsewhere in unit. Unit weathers to form steep ledgy slope	58
7. Quartzite (50 percent), siltstone (25 percent), and dolomite (25 percent). Quartzite, light-olive-gray (5*Y* 6/1), pale-yellowish-brown (10*YR* 6/2), and grayish-red (5*R* 4/2); very fine to fine-grained; indistinctly and irregularly laminated to thin bedded; rare very low angle cross-strata. Siltstone, yellowish-gray (5*Y* 8/1), pale-yellowish-brown (10*YR* 6/2), and grayish-red (5*R* 4/2); medium to coarse silt; some mica; platy. Dolomite, medium-gray (*N*5), light-olive-gray (5*Y* 6/1), and rare pale-red (10*R* 6/2) and pale-yellowish-brown (10*YR* 6/2); weathers dominantly moderate yellowish brown (10*YR* 5/4); aphanitic to very finely crystalline; laminated to very thin bedded. Rock types are interstratified in layers 1 in. to 5 ft thick. Unit as a whole weathers to form ledgy slope	96
6. Dolomite and minor amount of chert. Dolomite, light-olive-gray (5*Y* 6/1); weathers moderate yellowish brown (10*YR* 5/4); aphanitic to very finely crystalline; laminated to thin bedded; some layers are slightly undulating. Chert, olive-gray (5*Y* 4/1); cryptocrystalline; found in irregular layers and lenses that constitute about 10 percent of unit. Unit as a whole weathers to form ledge	9
Total of upper carbonate-bearing member (excludes top 15 ft of unit 9)	180

Siltstone member:

5. Siltstone (50 percent) and quartzite (50 percent). Siltstone, grayish-red (5*R* 4/2), yellowish-gray (5*Y* 8/1), light-greenish-gray (5*GY* 8/1), and light-olive-gray (5*Y* 6/1); medium to coarse silt; micaceous; platy; commonly grades to quartzite. Quartzite, light-gray (*N*7), yellowish-gray (5*Y* 8/1), light-olive-gray (5*Y* 6/1), and pale-yellowish-brown (10 *YR* 6/2), very fine to fine-grained; laminated 1-in. to 3-ft layers	

Locality 34—Continued

Salt Spring Hills No. 2 section, measured in southernmost part of Salt Spring Hills about 2 miles south-southwest of U.S. 127, southwestern part sec. 6 (unsurveyed), T. 17 N., R. 7 E.—Con.

Johnnie Formation—Continued

Siltstone member—Continued — Feet

5. Siltstone (50 percent), etc.—Continued interstratified with siltstone. Moderate-yellowish-brown (10*YR* 5/4) limy dolomite and dolomite occur from 5 to 6 ft, 69 to 70 ft, and 115.5 to 116.0 ft above base of unit; middle dolomite contains medium to very coarse quartz grains. Unit as a whole weathers to form slope. Thickness difficult to measure accurately owing to incompetent unit and presence of faults with small (3–5 ft) displacement — 123

Total of siltstone member — 123

Lower carbonate-bearing member:

4. Dolomite and sandy dolomite, minor amount of quartzite. Dolomite and sandy dolomite, light-gray (*N*7) to light-olive gray (5*Y* 6/1); weather light olive gray (5*Y* 6/1) and grayish orange (10*YR* 7/4); very finely crystalline (sandy parts contain very fine quartz grains and in a few places medium to coarse quartz grains); laminated to very thin bedded; rare low-angle cross-strata. Quartzite, yellowish-gray (5*Y* 8/1) and pale-yellowish-brown (10*YR* 6/2), very fine grained; some mica; laminated 1–15-in. layers interstratified with dolomite; minor constituent from 35 to 51 ft and in top 5 ft of unit. Unit as a whole weathers to form ledge — 83

Total of lower carbonate-bearing member — 83

Offset in section so that unit 4 measured 300 ft southeast of unit 3.

Quartzite member:

3. Quartzite, pale-red (10*R* 6/2), pinkish-gray (5*YR* 8/1), and yellowish-gray (5*Y* 8/1); weathers dark yellowish brown (5*YR* 4/1) with reddish cast; fine to medium grained; rare coarse-grained to very coarse grained parts; evenly laminated to thin bedded; rare low-angle cross-strata; weathers to form cliff. Unit contains a few thin layers of conglomerate with granules and small pebbles (as large as 21 mm) of quartz. Yellowish-gray (5*Y* 8/1) and pinkish-gray (5*YR* 8/1) argillite layers occur from 89 to 91 ft, 102 to 103 ft, and 105 to 106 ft above base of unit — 170

Total of quartzite member — 170

Offset in section so that unit 3 measured 1,500 ft southeast of unit 2.

Transitional member:

2. Dolomite and tremolite hornfels (80 percent) and quartzite (20 percent). Dolomite and

Locality 34—Continued

Salt Spring Hills No. 2 section, measured in southernmost part of Salt Spring Hills about 2 miles south-southwest of U.S. 127, southwestern part sec. 6 (unsurveyed), T. 17 N., R. 7 E.—Con.

Johnnie Formation—Continued

Transitional member—Continued — Feet

2. Dolomite and tremolite hornfels, etc.—Con. tremolite hornfels, very light gray (*N*8) to yellowish-gray, rare light-brown (5*YR* 6/4); weather very pale orange (10*YR* 8/2) to pale yellowish brown (10*YR* 6/2) and moderate yellowish brown (10*YR* 5/4); grade from medium-crystalline dolomite containing scattered crystals of tremolite to coarsely crysalline tremolite hornfels; largely obliterated stratification; sparse thin-bedded parts. Quartzite, yellowish-gray (5*Y* 8/1) to light-olive-gray (5*Y* 6/1), fine- to medium-grained; laminated 1-in. to 2-ft layer interstratified with rest of unit. Unit weathers to form steep slope. Unit is faulted and thickness given is not much better than an estimate. Quartzite occurs at base of unit or within a few feet of the base, and no Noonday Dolomite is considered to be present. Unit measured in a saddle — 180±

Total of transitional member — 180±

Total of Johnnie Formation — 898

Pahrump Group:

Kingston Peak Formation:

1. Argillite, dark-greenish-gray (5*GY* 4/1) to dark-gray (*N*5), fine-textured, evenly laminated; weathers to form gentle slope. About 50 ft below top of unit is 20(?)-ft-thick limestone unit. This limestone is dark gray (*N*3) (some laminae weather to moderate yellowish brown (10*YR* 5/4)), aphanitic to very finely crystalline, and thinly laminated to laminated (extremely evenly) — Unmeasured

Locality 35

Silurian Hills section, measured in the northwest corner of Silurian Hills, sec. 24 (unsurveyed), T. 17 N., R. 8 E.

[* denotes thickness measured by Kupfer (1960, fig. 5); ** denotes thickness modified by J. H. Stewart, November 1964]

Chambless Limestone: — Feet

29. Carbonate rock, algal(?); Kupfer's unit 35 — Unmeasured

Latham Shale:

28. Quartzite, limestone, and shale. Top 40 ft of Kupfer's unit 33 and all his unit 34. The trilobites *Paedeumias clarki* Resser and *Bistolia* sp. occur in upper part of unit (USGS colln. 4634–CO, identified by A. R. Palmer, written commun., 1965) — 90*

Total of Latham Shale — 90*

Locality 35—Continued

Silurian Hills section, measured in the northwest corner of Silurian Hills, sec. 24 (unsurveyed), T. 17 N., R. 8 E.—Continued

	Feet
Zabriskie Quartzite:	
27. Quartzite; light gray at base, pale pink in middle. white at top; medium grained. Kupfer's unit 33, except for bottom 60 ft and top 50 ft. Kupfer's thickness is considerably greater than thicknesses of this formation in nearby areas and therefore is probably too great. Field examination also suggests that Kupfer's thickness may be too great, although unit is highly faulted and thickness is difficult to determine	255*
Total of Zabriskie Quartzite	255*
Wood Canyon Formation:	
Upper member:	
26. Quartzitic siltstone and very fine to fine-grained quartzite. Minor amounts of dolomite. Top 445 ft of Kupfer's unit 31, all his unit 32, and bottom 60 ft of his unit 33. A prominent dark-colored (almost black) fine-grained quartzite occurs from 50 to 130** ft below base of Kupfer's unit 32. A similar and probably correlative quartzite occurs in the Salt Spring Hills	595*
Total of upper member	595*
Middle member:	
25. Quartzite and minor amounts of siltstone. Quartzite is cross-stratified and contains some conglomerate in lower 200 ft Bottom 505 ft of Kupfer's unit 31	505*
Total of middle member	505*
NOTE.—Lower member is absent.	
Total of Wood Canyon Formation	1, 100*
Stirling Quartzite:	
E member (units 22–24 correspond with Kupfer's unit 30):	
24. Quartzite, yellowish-gray and rare pinkish-gray, fine- to medium-grained, indistinctly bedded. A thin conglomerate occurs 5 ft below top of unit and contains granules and pebbles as large as 0.8 in. across	105**
23. Quartzite, yellowish-gray, minor pale-red and greenish-gray, fine- to medium-grained; possibly some of quartzite is dolomitic	40**
Total of E member	145**
D member:	
22. Dolomitic and (or) limy standstone, moderate-yellowish-brown and moderate-red, fine- to coarse-grained. Minor amounts of greenish-gray siltstone and silty fine-	

Locality 35—Continued

Silurian Hills section, measured in the northwest corner of Silurian Hills, sec. 24 (unsurveyed), T. 17 N., R. 8 E.—Continued

	Feet
Stirling Quartzite—Continued	
D member—Continued	
22. Dolomitic, etc.—Continued grained quartzite. Some of the sandstone is probably iron stained	5**
Total of D member	5**
C member (unit 21 corresponds with Kupfer's unit 29, unit 20 with his unit 28, and unit 19 with his unit 27):	
21. Siltstone and minor quartzite. Siltstone, greenish-gray; medium to coarse silt. Quartzite; greenish gray, silty, and fine grained in lower half of unit and pinkish gray and fine to medium grained in upper half. Amount of quartzite increases from 10 percent in basal part to about 60–70 percent in top 40 ft of unit	150**
20. Quartzite, pinkish-gray and yellowish-gray, fine-grained, evenly laminated to thin-bedded. A few greenish-gray silty sandstone layers occur in unit	41**
19. Quartzitic siltstone, greenish-gray. Minor amounts of pinkish-gray fine-grained quartzite occur in unit and become more prominent upwards. A 6-in. limestone (silty?) occurs 19 ft below top of unit; this limestone is light olive gray, weathers moderate yellowish brown, and is aphanitic to very finely crystalline	40**
Total of C member	231**
Offset in section so that overlying units measured 1,600 ft to east.	
B member (units 17 and 18 correspond to Kupfer's unit 26):	
18. Quartzite, grayish-red and yellowish-gray. Some siltstone in top 5–10 ft	52**
Total of B member	52**
A member:	
17. Quartzite, pinkish-gray to yellowish-gray	130**
Total of A member	130**
Total of Stirling Quartzite	563**
Offset in section so that overlying units measured 2,800 ft to southeast.	
Johnnie Formation (units 4–16 correspond to Kufer's unit 25):	
Rainstorm Member:	
Silstone unit:	
16. Siltstone, medium-gray to dark-greenish-gray; weathers dark gray; medium silt	28**
15. Dolomite, pale-yellowish-brown; weathers grayish orange; aphanitic to very finely crystalline; no oolites noted. Probably Johnnie oolite	5**

Locality 35—Continued

Silurian Hills section, measured in the northwest corner of Silurian Hills, sec. 24 (unsurveyed), T. 17 N., R. 8 E.—Continued

	Feet
Johnnie Formation (units 4–16 correspond to Kupfer's unit 25)—Continued	
Rainstorm Member—Continued	
Siltstone unit—Continued	
14. Siltstone, greenish-gray, light-greenish-gray, and pale-red; fine silt	8**
Total of siltstone unit	41**
Total of Rainstorm Member	41**
Upper carbonate-bearing member:	
13. Siltstone, yellowish-gray and pale-yellowish-brown. Minor amounts of very fine grained quartzite. Rare amounts of moderate-yellowish-brown-weathering dolomitic siltstone	23**
12. Dolomite, moderate-red and grayish-orange	1**
11. Quartzite, pinkish-gray and yellowish-gray, fine- to medium-grained; some coarse-grained to very coarse grained parts containing scattered granules and small pebbles	30**
10. Quartzite, pinkish-gray, fine- to medium-grained. Dolomite layers from 13 to 15 ft, 21 to 23 ft, and 27 to 28 ft above base of unit. Dolomite weathers grayish orange	28**
Offset so that overlying units measured 500 ft to west.	
9. Dolomite (50 percent) and quartzite (50 percent). Dolomite, pale-yellowish-brown; weathers grayish orange; very finely crystalline. Quartzite, pinkish-gray to pale-red, fine-grained. Dolomite occurs in two zones: one in about basal 5 ft and one in about top 5 ft	13**
8. Quartzite (70 percent), yellowish-gray to greenish-gray, very fine to fine-grained, laminated. Siltstone, greenish-gray and pale-red; fine to coarse silt. Unit from 35 to 53 ft is about 40 percent siltstone; rest of unit is about 20 percent. A dolomite layer occurs from 26 to 28 ft above base of unit. Unit forms cliff, but is otherwise similar to underlying unit	53**
7. Siltstone to quartzite, greenish-gray to dark-grenish-gray; coarse siltstone to very fine grained quartzite; laminated. Dolomite layers occur from 14 to 15 ft and 36 to 37 ft above base of unit	60**
6. Quartzite to siltstone (60 percent) and dolomite (40 percent). Quartzite to siltstone, greenish-gray; coarse siltstone to very fine grained quartzite; laminated. Dolomite, pale-yellowish-brown; weathers moderate yellowish brown; occurs in 2–12-in. layers	26**
Total of upper carbonate-bearing member	234**

Locality 35—Continued

Silurian Hills section, measured in the northwest corner of Silurian Hills, sec. 24 (unsurveyed), T. 17 N., R. 8 E.—Continued

	Feet
Johnnie Formation (units 4–16 correspond to Kupfer's unit 25)—Continued	
Siltstone member:	
5. Quartzite to siltstone, greenish-gray; very fine grained quartzite to coarse-grained siltstone only exposed in top 20 ft of unit, rest of unit covered where examined	70**
Total of siltstone member	70**
Lower carbonate-bearing member:	
4. Dolomite (80 percent) and quartzite (20 percent). Dolomite, pale-yellowish-brown and pale-red; weathers grayish orange; common sandy dolomite. Quartzite, yellowish-gray and pale-red, fine- to medium-grained	110**
Total of lower carbonate-bearing member	110**
Quartzite member:	
3. Quartzite, light-gray, coarse-grained. Scattered granules and pebbles of white quartz. Kupfer's unit 24	185*
Total of quartzite member	185*
Transitional member:	
2. Quartzite, yellowish-gray to pale-red; weathers dark yellowish brown; medium to coarse grained; probably dolomitic(?) in places. A few scattered granules and small pebbles of white quartz. Kupfer's unit 23	195*
Total of transitional member	195*
Total of Johnnie Formation	835*
Pahrump Group:	
Kingston Peak Formation:	
1. Siltstone, dark-gray; medium silt; evenly laminated. Siltstone is interstratified with 20–50-ft units of gray or brown sandstone. Much of sandstone is limy and (or) dolomitic, and some rock is grayish-orange-weathering sandy dolomite	Unmeasured

Locality 36

Northwest of Clark Mountain section, east-central part of sec. 14 and west-central part of sec. 13, T. 17 N., R. 12 E.

[Measured by J. H. Stewart and S. D. Stewart, October 1964]

	Feet
Wood Canyon Formation:	
13. Quartzite, light-brownish-gray (5*YR* 6/1); weathers dark yellowish brown (10*YR* 4/2); medium to coarse grained; some conglomeratic layers containing granules and small pebbles of quartz; composed dominantly of small- to medium-scale high-angle cross-strata; weathers	

Locality 36—Continued

Northwest of Clark Mountain section, east-central part of sec. 14 and west-central part of sec. 13, T. 17 N., R. 12 E.—Continued

	Feet
Wood Canyon Formation—Continued	
13. Quartzite, light-brownish-gray, etc.—Continued to form cliff. Float of medium-gray (*N*5) phyllitic siltstone occurs from about 3–10 ft above base of unit; probably this interval contains at least one layer of phyllitic siltstone, although basal 3 ft of unit is definitely quartzite	Unmeasured
NOTE.—Contact between Wood Canyon Formation and Stirling Quartzite placed at conspicuous color and textural change from light-colored vitreous quartzite below to dark-colored less vitreous quartzite above.	
Stirling Quartzite:	
E member:	
12. Quartzite, yellowish-gray (5*Y* 8/1); weathers same color and very pale orange (10*YR* 8/2); medium to coarse grained; laminated to thin bedded; minor thin tabular planar sets of cross-strata; weathers to form cliff. A conglomerate occurs from 3 to 5 ft below top of unit; this conglomerate contains granules and pebbles of white quartz set in a coarse-grained to very coarse grained matrix. Unit is somewhat faulted and thickness probably not very accurate	140
Total of E member	140
D member:	
11. Quartzite (85 percent) and dolomitic sandstone (15 percent). Quartzite, yellowish-gray (5*Y* 8/1), medium- to coarse-grained, laminated to very thin bedded; minor small-scale high-angle cross-strata. Dolomitic sandstone, very light gray (*N*8) to yellowish-gray (5*Y* 8/1); weathers dark-yellowish brown (10 *YR* 4/2); medium to coarse grained; laminated to very thin bedded; minor small-scale high-angle cross-strata; occurs as 0.5–2-ft layers interstratified with quartzite. Unit as a whole weathers to form basal part of cliff at top of Stirling Quartzite	55
Total of D member	55
C member:	
10. Phyllitic siltstone and quartzite. Phyllitic siltstone, greenish-gray (5*GY* 6/1); fine to coarse silt; micaceous. Quartzite, very pale orange (10*YR* 8/2) to pale-yellowish-brown (10*YR* 6/2), mostly fine grained, some medium- to coarse-grained, laminated to very thin bedded; rare tabular planar(?) sets of small-scale high-angle cross-laminae. Phyllitic siltstone is most abundant in lower 75± ft of unit and may constitute 50 percent of the strata; in rest of unit phyllitic siltstone may constitute about 10 percent of the strata	257

Locality 36—Continued

Northwest of Clark Mountain section, east-central part of sec. 14 and west-central part of sec. 13, T. 17 N., R. 12 E.—Continued

	Feet
Stirling Quartzite—Continued	
C member—Continued	
9. Quartzite, light-brownish-gray (5*YR* 6/1), fine-grained; some fine- to medium-grained parts; indistinctly very thin to thin bedded; weathers to form minor ridge	98
8. Phyllitic siltstone (50 percent) and quartzite (50 percent). Phyllitic siltstone, light-greenish-gray (5*GY* 8/1); fine silt; micaceous; well-developed schistosity. Quartzite, yellowish-gray (5*Y* 8/1), very fine to fine-grained, indistinctly laminated to thin-bedded; occurs as ½-in. to 2-ft layers interstratified with phyllitic siltstone. Unit as a whole weathers to form saddle	76
Total of C member	431
A and B members, undifferentiated:	
7 Quartzite, yellowish-gray (5*Y* 8/1) to very pale orange (10*YR* 8/2); weathers same colors and dark yellowish brown (10*YR* 4/2); medium to coarse grained; some fine-grained parts in upper half; laminated to thin bedded; common small- to medium-scale cross-strata; weathers to form prominent ridge. Conglomerate occurs in unit from 0 to 3 ft and from 9 to 13 ft above base of unit; it contains granules and pebbles of quartz set in coarse-grained to very coarse grained matrix; maximum size of pebbles about 1.5–2.0 in	178
Total of A and B members, undifferentiated	178
Total of Stirling Quartzite	804
Johnnie Formation (incomplete):	
Rainstorm(?) Member:	
Siltstone and quartzite(?) unit:	
6. Phyllitic siltstone (60 percent) and quartzite (40 percent). Phyllitic siltstone, light-greenish-gray (5*GY* 8/1) and yellowish-gray (5*Y* 8/1); coarse silt; micaceous. Quartzite, very pale orange (10*YR* 8/2) to pale-yellowish-brown (10*YR* 6/2), very fine grained, indistinctly laminated to thin-bedded; occurs in 0.5–2-ft layers interstratified with phyllitic siltstone. Top 4 ft are entirely phyllitic siltstone. Unit as a whole weathers to form slope	13
Total of siltstone and quartzite(?) unit	13

Locality 36—Continued

Northwest of Clark Mountain section, east-central part of sec. 14 and west-central part of sec. 13, T. 17 N., R. 12 E.—Continued

Johnnie Formation (incomplete)—Continued

Rainstorm(?) Member—Continued — Feet

Offset in section so that unit 6 measured 300 ft north of unit 5.

Carbonate(?) unit:

5. Quartzite (50 percent), phyllitic siltstone (30 percent), and dolomite (20 percent). Quartzite, yellowish-gray (5*Y* 8/1); weathers same color and dark yellowish brown (10*YR* 4/2); very fine grained; laminated to thin bedded. Phyllitic siltstone, greenish-gray (5*GY* 6/1), micaceous; well-developed schistosity. Dolomite, light-brownish-gray (5*YR* 6/1) to light-olive-gray (5*Y* 6/1); weathers moderate yellowish brown (10*YR* 5/4); finely crystalline; laminated; occurs as ½-in. to 1-ft layers interstratified with siltstone and quartzite. Quartzite in places is dolomitic(?) and weathers dusky yellowish brown (10*YR* 2/2). Unit as whole weathers to form ledgy outcrop — 65

Total of carbonate(?) unit — 65

Total of Rainstorm(?) Member — 78

Offset in section so that unit 5 measured 500 ft east of unit 4.

Possible equivalent of siltstone and upper carbonate-bearing members, undifferentiated:

4. Quartzite and phyllitic siltstone. Quartzite, very pale orange (10*YR* 8/2) to pale-yellowish-brown (10*YR* 6/2), very fine grained, laminated to very thin bedded; occurs in 1-in. to 10-ft layers interstratified with phyllitic siltstone. Phyllitic siltstone, light-greenish-gray (5*GY* 8/1) to greenish-gray (5*GY* 6/1); fine to coarse silt; micaceous; platy cleavage. Unit as a whole weathers to form steep slope. Exact thickness of unit uncertain owing to minor folding at top of unit. Unit is divided into two parts on the basis of relative amounts of quartzite and phyllitic siltstone. From 0 to 65 ft, 80 percent of strata is phyllitic siltstone and 20 percent is quartzite; from 65 to 140 ft, 20 percent of strata is phyllitic siltstone and 80 percent is quartzite. At some places along outcrops of unit one or two thin dolomite layers, similar to those in unit 3, occur in unit — 140±

Total of possible equivalent of siltstone and upper carbonate-bearing members, undifferentiated — 140±

Locality 36—Continued

Northwest of Clark Mountain section, east-central part of sec. 14 and west-central part of sec. 13, T. 17 N., R. 12 E.—Continued

Johnnie Formation (incomplete)—Continued — Feet

NOTE.—Top 47 ft of unit 3 probably equivalent to lower carbonate-bearing member; underlying part of Johnnie Formation probably equivalent to transitional and quartzite members, undifferentiated.

3. Dolomite, quartzite to dolomitic sandstone, and phyllitic siltstone. Dolomite, light-olive-gray (5*Y* 6/1) to medium-gray (*N*5); weathers moderate yellowish brown (10*YR* 5/4); very finely to finely crystalline; evenly laminated; some gentle undulations to stratification locally. Quartzite to dolomitic sandstone, very pale orange (10*YR* 8/2) to pale-yellowish-brown (10 *YR* 6/2), yellowish-gray (5*Y* 8/1), and medium-gray (*N*5); weathers same colors (dolomitic parts tend to weather dark yellowish brown (10*YR* 4/2)); very fine to fine grained; laminated; rare small-scale high- and low-angle cross-strata; phyllitic siltstone, light-greenish-gray (5*GY* 8/1) to medium-gray (*N*5); fine to coarse silt; micaceous. Dolomite and quartzite occur interstratified in layers 0.5–3 ft thick; phyllitic siltstone probably occurs in very thin layers although it is poorly exposed. Sequence in unit is as follows: 0–60 ft, 35 percent dolomite, 65 percent quartzite to dolomitic sandstone; 60–120 ft, 80 percent quartzite and minor dolomitic sandstone, 20 percent phyllitic siltstone; 120–167 ft, 50 percent dolomite, 50 percent quartzite to dolomitic sandstone. Unit as a whole weathers to form gentle ledgy slope — 167±

2. Quartzite, very pale orange (10*YR* 8/2) to pale-yellowish-brown (10*YR* 6/2), fine- to medium-grained; some medium- to coarse-grained parts; in lower 5 ft common conglomeratic parts containing granules and pebbles (as large as about ¾ in.) of quartz; laminated to thin bedded; minor small-scale high- and low-angle cross-strata; weathers to form ledge — 37

Total of incomplete Johnnie Formation — 422

NOTE.—Probably fault cuts out basalmost part of Johnnie Formation and all of a dolomite unit which is probably the Noonday Dolomite. The Noonday is at least 100 ft thick both to the north (about 1,500 ft) and to the south (500 ft).

Older Precambrian rocks:

1. Gneiss, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1); composed of quartz, feldspar, and biotite; coarsely crystalline; well-defined schistosity; weathers to form slope. Top 25± feet of gneiss is altered(?) to pale red (10*R* 6/2) and light greenish gray (5*GY* 8/1); these colors are intermixed in large irregular patches — Unmeasured

Locality 38

Silver Lake section, measured in hills west of Silver Lake and ¼–½ mile south of powerline, northwestern part sec. 29, T. 15 N., R. 8 E. Upper member of Wood Canyon Formation and Zabriskie Quartzite examined in southeastern part sec. 30, T. 15 N., R. 8 E.

[Measured by J. H. Stewart, November 1964]

Zabriskie Quartzite: *Feet*

The Zabriskie Quartzite occurs as a breccia, perhaps about 50 ft thick, composed of angular blocks, some about 5 ft across, of yellowish-gray (5*Y* 8/1) to very pale orange (10*YR* 8/2) fine- to coarse(?)-grained quartzite. Grain size is largely obscured by metamorphism and brecciation. To south, Zabriskie breccia is covered by windblown sand. In valley about 1,000 ft south and in low hills to south of there, evenly laminated very light gray limestone and some quartzitic siltstone occur; these limestone and siltstone strata may be equivalent to part of the Carrara Formation. Some quartzite also occurs south of the valley, but this quartzite could be the Wood Canyon Formation repeated by faulting ---------- Unmeasured

Wood Canyon Formation (only partly measured):

Upper member:

The upper member in the Silver Lake area consists of dark-gray (*N*3) quartzitic siltstone and yellowish-gray (5*Y* 8/1) to pale-yellowish-brown (10*YR* 6/2), very fine to fine-grained, evenly laminated quartzite. The quartzite appears to be the predominant rock type. Mud cracks(?) and various borings and trails(?) occur rarely on bedding planes. The top 100 ft, approximately, contains about 50 percent light-olive-gray (5*Y* 6/1) to pale-yellowish-brown (10*YR* 6/2) coarsely crystalline laminated limy dolomite. The limy dolomite is in layers 0.5 ft to about 10 ft thick; it occurs directly below breccia of Zabriskie Quartzite, but some uppermost beds of the member probably have been removed by structural movement along base. Upper member appears generally similar to that at Salt Spring Hills and is probably of a comparable thickness ---------- Unmeasured

Middle member (incomplete):

NOTE.—Units 18 and 19 are the basal two units of the middle member; the rest of the member was not measured because of faulting that makes accurate measurements impossible. Unit 19 probably corresponds with the conglomeratic unit in the middle member in the Salt Spring Hills section; the remainder of the middle member probably consists of quartzite similar to that in unit 19 and minor amounts of dark-gray (*N*3) quartzitic siltstone. The member in the Silver Lake area appears to be similar to that in the Salt Spring Hills area and is probably of a similar thickness.

19. Quartzite, very light gray (*N*7) to medium-gray (*N*5), and minor olive-gray (5*Y* 4/1), fine- to medium-grained and medium- to coarse-grained; rare conglomeratic parts with granules and small pebbles of quartz; laminated; common low-angle small-scale cross-

Locality 38—Continued

Silver Lake section, measured in hills west of Silver Lake and ¼–½ mile south of powerline, northwestern part sec. 29, T. 15 N., R. 8 E. Upper member of Wood Canyon Formation and Zabriskie Quartzite examined in southeastern part sec. 30, T. 15 N., R. 8 E.—Continued

Wood Canyon Formation, etc.—Continued

Middle member (incomplete)—Continued

19. Quartzite, very light gray, etc.—Continued *Feet*
strata; some high-angle cross-strata; weathers to form cliff. Unit contains rare amounts of quartzitic siltstone similar to that in underlying unit. Unit measured to top of cliff; overlying strata contain more quartzitic siltstone than this unit ---------- 180
18. Quartzite (60 percent) and quartzitic siltstone (40 percent). Quartzite, medium-gray (*N*5) and yellowish-gray (5*Y* 8/1), fine- to medium-grained and medium- to coarse-grained, laminated; minor very low angle cross-strata; occurs as 0.2–2-ft layers interstratified with quartzitic siltstone. Quartzitic siltstone, dark-gray (*N*3), micaceous, laminated; occurs in 0.2–2-ft layers. Unit weathers to form slope ---------- 44

Total of incomplete middle member ---------- 224

Lower member:

17. Quartzite (70 percent) and quartzitic siltstone (30 percent). Quartzite, dark-gray (*N*3) and rare yellowish-gray (5*Y* 8/1), mostly very fine- to fine-grained, rare fine- to medium-grained parts laminated. Quartzitic siltstone, dark-gray (*N*3); coarse(?) silt; grades into very fine grained quartzite. Unit weathers to form slope ---------- 14
16. Dolomite, yellowish-gray (5Y 8/1) to pale-yellowish-brown (10*YR* 6/2); weathers dark yellowish brown (10*YR* 4/2) to moderate yellowish brown (10*YR* 5/4); coarsely crystalline; laminated; weathers to form ledge. Contains laminae of fine-grained dolomitic(?) quartzite ---------- 10
15. Quartzite (70 percent) and quartzitic siltstone (30 percent). Quartzite, yellowish-gray (5*Y* 8/1) to pale-yellowish-brown (10*YR* 6/2), very fine grained, evenly laminated. Quartzitic siltstone, light-greenish-gray (5*GY* 8/1); coarse silt; laminated in part. Unit as a whole weathers to form slope ---------- 17
14. Dolomite, olive-gray (5*Y* 4/1); weathers dark yellowish brown (10*YR* 4/2); coarsely crystalline; evenly laminated; weathers to form minor ledge. Some parts of unit are very poorly exposed and may contain thin layers of quartzitic siltstone or quartzite ---------- 5
13. Covered ---------- 3

Total of lower member ---------- 49

Total of Wood Canyon Formation (only partly measured) ---------- 273

Locality 38—Continued

Silver Lake section, measured in hills west of Silver Lake and ¼–½ mile south of powerline, northwestern part sec. 29, T. 15 N., R. 8 E. Upper member of Wood Canyon Formation and Zabriskie Quartzite examined in southeastern part sec. 30, T. 15 N., R. 8 E.—Continued

	Feet
Stirling Quartzite:	
E member:	
12. Quartzite, yellowish-gray (5*Y* 8/1), fine- to medium-grained and medium- to coarse-grained (difficult to see grain size of much of rock owing to metamorphism); rare thin layers containing granules and very small pebbles of quartz; laminated; rare small-scale low-angle cross-strata; weathers to form light-colored cliff. Unit contains medium-gray (*N*5), micaceous quartzitic siltstone to very fine grained quartzite from 24 to 28 ft below top of unit and from 5 to 6 ft below top of unit	260
Total of E member	260
NOTE.—D member is absent.	
C member:	
11. Quartzite, light-greenish-gray (5*GY* 8/1), greenish-gray (5*GY* 6/1), and yellowish-gray (5*Y* 8/1), very fine to fine-grained, and fine- to medium-grained; laminated in some places; weathers to form slope. Some of greenish-gray layers are probably silty very fine grained quartzite	60
10. Quartzitic siltstone to very fine grained quartzite; dark gray (*N*3) to dark greenish gray (5*GY* 6/1); micaceous; some laminated parts; weather to form slope	30
Offset in section so that unit 10 measured 200 ft north of unit 9.	
9. Quartzitic siltstone (80 percent) and quartzite (20 percent). Quartzitic siltstone, dark-gray (*N*3), micaceous; probably coarse silt originally; laminated. Quartzite, yellowish-gray (5*Y* 8/1), fine-grained; occurs in ½–3-in. layers. Unit as a whole weathers to form black ledge	30±
8. Phyllitic siltstone to fine-grained quartzite, very pale orange (10*YR* 8/2), pale-yellowish-brown (10*YR* 8/2), and minor light-olive-gray (5*Y* 6/1); coarse-grained micaceous phyllitic siltstone to micaceous fine-grained quartzite; rare fine- to medium-grained quartzite; irregularly laminated; weather to form slope. Unit is probably mostly very fine to fine-grained quartzite. Unit at 35 ft contains thin layer of moderate-yellowish-brown (10*YR* 5/4) dolomitic(?) siltstone	80
Offset in section so that unit 8 measured 500 ft south of unit 7.	
7. Quartzitic siltstone (90 percent) and quartzite (10 percent). Quartzitic siltstone, dark-gray (*N*3); coarse silt-sized particles; common mica. Quartzite, yellowish-gray (5*Y* 8/1)	

Locality 38—Continued

Silver Lake section, measured in hills west of Silver Lake and ¼–½ mile south of powerline, northwestern part sec. 29, T. 15 N., R. 8 E. Upper member of Wood Canyon Formation and Zabriskie Quartzite examined in southeastern part sec. 30, T. 15 N., R. 8 E.—Continued

	Feet
Stirling Quartzite—Continued	
C member—Continued	
7. Quartzite siltstone, etc.—Continued and minor medium-gray (*N*5), medium(?)-grained, laminated; occurs as ½–4-in. layers. Unit weathers to form black ledge	6
Total of C member	206
A and B members, undifferentiated:	
6. Quartzite, yellowish-gray, fine- to coarse-grained, mostly fine- to medium-grained; conglomeratic quartzite with quartz pebbles as large as 11 mm in basal few feet; laminated; common very low angle cross-strata (2°–5° inclination); weathers to form prominent ledge	85
5. Phyllite (85 percent) and quartzite (15 percent). Phyllite, dark-greenish-gray (5*GY* 4/1) to dark-gray (*N*3), very fine textured, micaceous. Quartzite, yellowish-gray (5*Y* 8/1), fine- to coarse-grained; some laminated parts; occurs in 1–10-in. layers. Unit weathers to form slope. On the basis of the coarse-grained quartzite, I am inclined to place the unit in the Stirling, although it could be placed in uppermost Johnnie	23
Total of A and B members, undifferentiated	108
Total of Stirling Quartzite	574
Johnnie Formation (incomplete):	
Rainstorm(?) Member:	
Carbonate unit:	
4. Dolomite, yellowish-gray (5*Y* 8/1); weathers very pale orange (10*YR* 8/2); very coarsely to coarsely crystalline; faintly laminated in places; weathers to form prominent light-colored ledge at base of major outcrops	28
Total of carbonate unit	28
Siltstone unit:	
3. Quartzitic siltstone to quartzite, dark-greenish-gray (5*GY* 4/1); micaceous phyllitic and quartzitic siltstone to very fine grained quartzite; laminated; exposed at head of gully. Much of rock could probably be called a phyllite	40±
Total of siltstone unit	40±
Total of Rainstorm(?) Member	68±

Locality 38—Continued

Silver Lake section, measured in hills west of Silver Lake and ¼–½ mile south of powerline, northwestern part sec. 29, T. 15 N., R. 8 E. Upper member of Wood Canyon Formation and Zabriskie Quartzite examined in southeastern part sec. 30, T. 15 N., R. 8 E.—Continued

Johnnie Formation (incomplete)—Continued

Upper carbonate-bearing(?) member: *Feet*

2. Quartzite, yellowish-gray (5*Y* 8/1), pale-yellowish-brown (10*YR* 6/2), greenish-gray (5*Y* 6/1), and medium-gray (*N*5), mostly fine grained; some fine- to medium-grained parts with minor coarse grains; laminated; rare very low angle cross-strata; exposed in gully. Some quartzite contains minor amounts of fine-textured material (probably silt originally) and common mica .... 55±
1. Phyllitic siltstone to quartzite, light-olive-gray (5*Y* 6/1), light-greenish-gray (5*GY* 8/1), and pale-yellowish-brown (10*YR* 6/2); micaceous phyllitic siltstone to micaceous very fine grained quartzite; laminated to very thin bedded; exposed in small gully .... 30±

Total of upper carbonate-bearing(?) member .... 85±

Total of incomplete Johnnie Formation .... 153±

Locality 39 (section 1)

Old Dad Mountain No. 1 section, measured in northern part of Old Dad Mountain area, about 1 mile south-southeast of Brannigan mine, southeastern part sec. 26 and southwestern part sec. 25, T. 13 N., R. 10 E.

[Measured by J. H. Stewart, October 1964]

Stirling Quartzite (incomplete): *Feet*

10. Quartzite, yellowish-gray (5*Y* 8/1) to very light gray (*N*8), fine- to medium-grained and medium- to coarse-grained, indistinctly thin bedded; weathers to form ridge. Basal 10 ft is conglomerate and conglomeratic quartzite with granules and small pebbles (as large as 0.6 in.) of white quartz. Top of unit is at rhyolite(?) dike. Dike is about 20 ft across and beyond dike is about 85 ft of quartzite similar to unit 10. This quartzite beyond dike could be a continuation of unit 10 or a part of unit 10 already measured and repeated by faulting. South of outcrops of quartzite similar to unit 10 (including the 85 ft mentioned above) is a fault that repeats units 1–5 155

Total of incomplete Stirling Quartzite 155

Johnnie Formation:

Rainstorm Member:

Carbonate unit:

9. Dolomitic limestone to silty dolomitic limestone, pale-yellowish-brown (10*YR* 6/2) to yellowish-gray (5*Y* 8/1); weather former color; finely crystalline; some silty (coarse silt) parts; indistinctly laminated to thin bedded; generally poorly exposed; form slope 10

Total of carbonate unit 10

Siltstone unit:

8. Quartzite and silty quartzite, medium-dark-gray (*N*4) to olive-gray (5*Y* 4/1); weather brownish black (5*YR* 2/1); very fine grained; some silty parts and possible gradations to sandy coarse-grained siltstone locally; common white mica; evenly laminated to thin bedded; flaggy to blocky splitting; weather to form slope with some minor ledges .... 110±
7. Siltstone, medium-dark-gray (*N*4) to olive-gray (5*Y* 4/1); medium silt; micaceous; platy to flaggy splitting; weathers to form black slope continuous with that of unit 8. Gradational into overlying unit. Thickness of units 7 and 8 approximate because of faulting and presence of intrusive dikes and silt .... 40±
6. Dolomite (Johnnie oolite); pale yellowish brown in lower 5 ft and very pale orange (10*YR* 8/2) in upper 6 ft; weathers grayish orange (10*YR* 7/4); aphanitic to very finely crystalline. Top 6 ft oolitic in places. Lower 5 ft laminated to very thin bedded; upper 6 ft structureless. Unit weathers to form minor ledge. Bottom 5 ft of unit contains a minor amount (20 percent(?)) of pale-yellowish-brown (10*YR* 6/2) siltstone and appears gradational with unit 5 11

Total of siltstone unit (includes top 16 ft of unit 5) .... 177±

Total of Rainstorm Member .... 187±

Upper carbonate-bearing member (excludes top 16 ft of unit 5):

5. Siltstone and quartzite. Siltstone, pale-yellowish-brown; weathers same color and grayish orange (10*YR* 7/4); medium silt; platy splitting. Quartzite, pale-red (5*R* 6/2) and yellowish-gray (5*Y* 8/1), very fine grained, micaceous, laminated to thin-bedded; platy splitting in part. Unit is poorly exposed in places, but is probably dominantly (entirely?)

Locality 39 (section 1)—Continued

Old Dad Mountain No. 1 section, measured in northern part of Old Dad Mountain area, about 1 mile south-southeast of Brannigan mine, southeastern part sec. 26 and southwestern part sec. 25, T. 31 N., R. 10 E.—Continued

Johnnie Formation—Continued

Upper carbonate-bearing member, etc.—Continued

	Feet
5. Siltstone and quartzite, etc.—Continued quartzite in lower 40 ft and dominantly (entirely?) siltstone in upper 16 ft of unit. Unit is cut by two sills of mafic igneous rock; these sills were not included in thickness of unit	56
4. Dolomite, medium-gray (*N*5) to light-gray (*N*7), and minor light-olive-gray (5*Y* 6/1); minor medium dark gray (*N*4) in top 30 ft; aphanitic to finely crystalline; thinly laminated to laminated and very thin bedded. Bottom 50 ft of unit contains irregular lenses and masses of chert; some ¼–½-in. spheres of chert occur in bottom 5 ft of unit. Unit weathers to form prominent hogback. Unit from 9 to 19 feet above base contains a minor amount of pale-yellowish-brown (5*YR* 6/2) and yellowish-gray (5*Y* 8/1) fine- to course-grained micaceous siltstone; a few thin layers of siltstone occur elsewhere in unit. Three thin layers of quartzite occur from 24 to 34 ft below top of unit; this quartzite is pale yellowish brown (5*YR* 6/2), fine grained, and laminated; one or two thin layers of a similar-appearing quartzite also occur in top 4 ft of unit	84
Total of upper carbonate-bearing member (excludes top 16 ft of unit 5)	124

Siltstone(?) member:

3. Siltstone (35 percent), quartzite (35 percent), and dolomite (30 percent). Siltstone, pale-yellowish-brown (10*YR* 6/2) and pale-red (5*R* 6/2); coarse silt; micaceous; platy splitting. Quartzite, pale-yellowish-brown (10*YR* 4/2) to medium-gray (*N*5), very fine to fine-grained, laminated. Dolomite; similar to that in unit 2, except that it weathers mostly moderate yellowish brown (10*YR* 5/4) and except that some parts are limy. Dolomite decreases in amount upwards in unit. All three lithologic types interstratified in layers 3–18 in. thick. Unit weathers to form slope	55
Total of siltstone(?) member	55

Lower carbonate-bearing member:

2. Dolomite, yellowish-gray (5*Y* 7/2) to medium-gray (*N*5); weathers yellowish gray (5*Y* 7/2) to light gray (*N*7); aphanitic to very finely crystalline; laminated; rare very low angle small-scale cross-strata; weathers to form cliff	90
Total of lower carbonate-bearing member	90

Locality 39 (section 1)—Continued

Old Dad Mountain No. 1 section, measured in northern part of Old Dad Mountain area, about 1 mile south-southeast of Brannigan mine, southeastern part sec. 26 and southwestern part sec. 25, T. 31 N., R. 10 E.—Continued

Johnnie Formation—Continued

Quartzite member (incomplete):

	Feet
1. Quartzite and minor dolomite. Quartzite, yellowish-gray (5*Y* 8/1), pinkish-gray (5*YR* 8/1), and pale-red (5*R* 6/2), medium- to coarse-grained; some fine-grained parts; laminated to very thin bedded; rare low-angle cross-strata. Dolomite, medium-light-gray (*N*6) to light-gray (*N*7); weathers same colors and yellowish gray (5*Y* 7/2); very finely crystalline; laminated. Dolomite occurs in following positions in unit: 36.0–36.5 ft, 51–55 ft, and 65.5–70.0 ft above base of unit. Some of the dolomite is limy and may grade to dolomitic limestone. Unit contains a conglomerate from 20 to 21 ft below top of unit; conglomerate contains granules and pebbles as large as 1.5 in. in diameter of white quartz	75
Total of incomplete quartzite member	75
Total of incomplete Johnnie Formation	531

Base of section; underlying strata are too faulted for accurate measurements of thickness. Unit 1 may be 100–200 ft thick and rest directly on older Precambrian gneiss, but this cannot be definitely established.

Locality 39 (section 2)

Old Dad Mountain No. 2 section, measured in northern part of Old Dad Mountain area, about 1 mile southeast of Brannigan mine, west-central part sec. 25, T. 13 N., R. 10 E.

[Measured by J. H. Stewart and S. D. Stewart, November 1964]

Stirling Quartzite (incomplete):

E member:

	Feet
12. Quartzite, yellowish-gray (5*Y* 8/1) weathers same color and dark yellowish brown (10*YR* 4/2); fine to medium grained; scattered coarse grains in some places; laminated to thin bedded; some low-angle cross strata; weathers to form ledgy and rocky hills. Top 30 ft of unit may be faulted, but rest of unit appears to be unfaulted. More of unit may be exposed, but faulting and poor outcrops make determination of section difficult	150±
Total of E member	150±

D(?) member:

11. Quartzite, sandy dolomite, sandy limy dolomite, and dolomite. Quartzite, yellowish-gray (5*Y* 8/1) and minor light-greenish-gray (5*GY* 8/1); weathers yellowish gray (5*GY* 8/1) and dark yellowish brown (10*YR* 4/2); fine

Locality 39 (section 2)—Continued

Old Dad Mountain No. 2 section, measured in northern part of Old Dad Mountain area, about 1 mile southeast of Brannigan mine, west-central part sec. 25, T. 13 N., R. 10 E.—Continued

Stirling Quartzite (incomplete)—Continued

D(?) member—Continued *Feet*

11. Quartzite, sandy dolomite, etc.—Continued to medium grained; very rare micaceous parts; laminated; rare small-scale cross-strata. Sandy dolomite, sandy limy dolomite, and dolomite, light-brownish-gray (5*YR* 6/1) and pale-yellowish-brown (10*YR* 6/2); weather moderate yellowish brown (10*YR* 5/4) to dark yellowish brown (10*YR* 4/2) (sandy parts contain medium to coarse rounded quartz grains); laminated; rare small-scale cross-strata; dominantly sandy dolomite. Dolomite strata from 24 to 25 ft, 31 to 45 ft, 54 to 55 ft, 58 to 59 ft above base of unit and in two thin layers in top 4 ft of unit. Unit weathers to form ledgy slope 69
10. Siltstone and quartzite, similar to that in unit 9, and three carbonate layers. The lower carbonate layer is in the basal 0.5 ft of unit and is moderate yellowish brown very finely crystalline limestone. The middle carbonate layer occurs from 56.5 to 58.5 ft above base of unit and is brownish-gray (5*YR* 4/1) (weathers moderate-yellowish-brown (10*YR* 5/4)) sandy limy dolomite with fine to medium grains of quartz. The upper carbonate layer is in the top 0.5 ft of the unit and is pale-yellowish-brown (10*YR* 6/2) dolomite. Unit also contains yellowish-gray medium- to coarse-grained quartzite from 4 to 5 ft above base of unit and two other thin layers of this coarse quartzite in interval from 20 to 25 ft below top of unit. Unit weathers to form a slope 64

Total of D(?) member 133

C member:

9. Siltstone and quartzite. Siltstone, dark-greenish-gray (5*GY* 4/1) and brownish-gray (5*YR* 4/1); some parts with purple cast; mostly fine silt; micaceous; platy splitting. Quartzite, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1), and medium-gray (*N*5); some parts with purplish cast; very fine to fine grained; micaceous; laminated; rare ripple marks and drag marks(?) on stratifications planes; occurs as ½–6-in. layers interstratified with siltstone. Quartzite constitutes about 15 percent of strata in lower 95 ft of unit and about 40 percent of strata in rest of unit. Basal 18 ft of unit contains several 1–6-in. layers of moderate-yellowish-brown

Locality 39 (section 2)—Continued

Old Dad Mountain No. 2 section, measured in northern part of Old Dad Mountain area, about 1 mile southeast of Brannigan mine, west-central part sec. 25, T. 13 N., R. 10 E.—Continued

Stirling Quartzite (incomplete)—Continued

C member—Continued *Feet*

9. Siltstone and quartzite, etc.—Continued (10*YR* 5/4) very finely crystalline limestone. Unit as a whole weathers to form slope 184

Offset in section so that overlying units measured starting about 300 ft to east of unit 8. After offset, rhyolite dikes occur above dolomitic sequence of units 6–8, but probably little, if any, section was gained or lost by offset.

8. Dolomitic limestone; similar to unit 6 2
7. Silstone, olive-gray (5*Y* 4/1); medium silt; micaceous; platy splitting; weathers to form slope 8
6. Dolomitic limestone, moderate-yellowish-brown (10*YR* 5/4) to dark-yellowish-brown (10*YR* 4/2), very finely crystalline, laminated; weathers to form small ledge 1
5. Siltstone, dark-greenish-gray (5*GY* 4/1) to medium-gray (*N*5); fine silt; some mica; platy splitting; weathers to form a saddle 15

Total of C member 210

B(?) member:

4. Quartzize; similiar to unit 3, except that there is a minor amount of yellowish-gray (5*Y* 7/2) and grayish-yellow (5*Y* 8/4) very fine grained micaceous quartzite. Unit also contains a minor amount of grayish-yellow (5*Y* 8/4) to dusky-yellow (5*Y* 6/4) coarse siltstone in top 14 ft 38

Total of B(?) member 38

A member:

3. Quartzite, yellowish-gray (5*Y* 8/1), fine- to medium-grained; rare coarse-grained parts; laminated; rare low-angle cross-strata. Lower 20 ft of unit contains conglomeratic quartzite to conglomerate. The conglomeratic rocks contain quartz pebbles as large as 18 mm in maximum diameter. Unit weathers to form a ridge 155

Total of A member 155

Total of incomplete Stirling Quartzite 686

Johnnie Formation (incomplete):

2. Dolomitic(?) limestone, pale-yellowish-brown (10*YR* 6/2), very finely crystalline, laminated, same as unit 9 of stratigraphic section at locality 39 16
1. Coarse-grained siltstone to silty very fine grained quartzite, medium-gray (*N*5); same as unit 8 of stratigraphic section at locality 39 .... Unmeasured

Locality 41

Providence Mountains section, measured on west side of north-trending ridge about 1½ miles west of Tough Nut Spring, southwestern part sec. 25 (unsurveyed), T. 11 N., R. 13 E.

[Measured by J. H. Stewart, October 1964]

	Feet
Chambless Limestone:	
15. Limestone, medium-gray (*N*5), medium-crystalline, indistinctly laminated to thin-bedded; weathers to form prominent ledge. Contains abundant *Girvanella*	Unmeasured
Latham Shale:	
14. Quartzitic siltstone, light-olive-gray (5*Y* 6/1) to olive-gray (5*Y* 4/1); fine to coarse silt; micaceous in part; laminated to thin bedded; weathers to form slope and prominent bench. Unit contains a few very fine grained silty quartzite layers. Quartzitic siltstone contains some indistinct "worm trails" and other markings on bedding-plane surfaces	87
Total of Latham Shale	87
Zabriskie Quartzite:	
13. Quartzite, yellowish-gray (5*Y* 8/1) to pinkish-gray (*YR* 8/1), medium- to coarse-grained; fine to medium grained in part; indistinct thin to thick beds; weathers to form prominent light-colored cliff	70
Total of Zabriskie Quartzite	70
Wood Canyon Formation:	
Upper member:	
12. Quartzitic siltstone (80 percent) and quartzite (20 percent). Quartzitic siltstone, light-olive-gray (5*Y* 6/1) to olive-gray (5*Y* 4/1), and dark-gray (*N*3); coarse silt; micaceous in some places; evenly laminated to very thin bedded. Quartzite, yellowish-gray (5*Y* 8/1) to light-olive-gray (5*Y* 6/1), very fine grained; silty in places and grades into sandy coarse siltstone; evenly laminated 4-in. to 3-ft layers interstratified with quartzitic siltstone. Quartzite and quartzitic siltstone are gradational and difficult to distinguish. Lower one-fourth of unit probably contains only a minor amount (5 percent) of quartzite, and quartzite is probably most abundant in top one-fourth of unit. Unit as a whole weathers to form slope and prominent bench in section. *Scolithus* tubes noted in quartzitic siltstone from 165 to 168 ft above base of unit	191
Total of upper member	191
Offset in section so that unit 12 measured 300 ft southwest of unit 11.	
Middle member:	
11. Quartzite (80 percent) and quartzitic siltstone (20 percent). Quartzite, dusky-yellow (5*Y* 6/4) and light-olive-gray (5*Y* 6/1); weathers same colors and dark yellowish brown (10 *YR* 4/2); mostly fine to medium grained; fine grained in part and coarse to very coarse grained in part; composed of thin trough and tabular planar sets of high-angle small-scale cross-laminae. Quartzitic siltstone, medium-dark-gray (*N*4) to olive-gray (5*Y* 4/1); coarse silt; commonly micaceous; evenly laminated 1-in. to 3-ft layers interstratified with quartzite. Quartzitic siltstone in places appears to contain incipient dark mineral aggregates about 1–3 mm across. Unit as a whole weathers to form cliff. Abundant vertical tabular borings (*Scolithus*?) noted in an 8-in. silty quartzite layer about 3 ft below top of unit. Top few feet of unit 11 and bottom few feet of unit 12 are transitional sequence between the two units	292
10. Quartzite and rare (2–3 percent) conglomerate, dusky-yellow (5*Y* 6/4) and pale-yellowish-brown (10*YR* 6/2), medium-to coarse-grained; mostly composed of thin trough and tabular planar sets of small-scale cross-strata; weather to form prominent cliff. Conglomerate composed of granules and pebbles (as large as 38 mm) set in a coarse-grained to very coarse grained matrix. Unit contains a few thin layers of dark-greenish-gray (5*GY* 4/1) micaceous quartzitic siltstone. Unit transitional into overlying unit across about 50 ft of beds	155
Total of middle member	447
Total of Wood Canyon Formation	638

NOTE.—Lower member of Wood Canyon Formation is absent.

NOTE.—Contact between Stirling Quartzite and Wood Canyon Formation not conspicuous, but placed at subtle change in character of quartzite. The quartzite in the Stirling tends to be very pale orange and vitreous; that in the Wood Canyon tends to be dusky yellow, crumbly, and not very vitreous.

	Feet
Stirling Quartzite:	
E member:	
9. Quartzite, very pale orange (10 *YR* 8/2) to yellowish-gray (5*Y* 8/1); weathers same colors and dark yellowish brown (10*YR* 4/2); medium to coarse grained; laminated to very thin bedded; minor amounts of small-scale low- and high-angle cross-laminae; weathers to form lower part of prominent cliff. Unit contains a few conglomeratic layers with	

Locality 41—Continued

Providence Mountains section, measured on west side of north-trending ridge about 1½ miles west of Tough Nut Spring, southwestern part sec. 25 (unsurveyed), T. 11 N., R. 13 E.—Continued

	Feet
Stirling Quartzite—Continued	
E member—Continued	
9. Quartzite, very pale orange, etc.—Continued granules and pebbles as large as 10 mm in diameter. Unit contains a few quartzitic siltstone layers that are similar to those in underlying unit; the quartzitic siltstone occurs from 21 to 24 ft, 35 to 37 ft, 39 to 41 ft, and as two thin layers in interval from 62 to 64 ft above base of unit	76
Total of E member	76

NOTE.—D member is absent.

	Feet
C member:	
8. Quartzitic siltstone and quartzite. Quartzitic siltstone, dark-greenish-gray (5*GY* 4/1); coarse silt; evenly laminated very thin to thin beds in lower 30 ft of unit, where it constitutes about 20 percent of strata; from 30 to 56 ft quartzitic siltstone constitutes about 80 percent of strata. Unit contains two types of quartzite: quartzite in lower 30 ft is pale yellowish brown (10*YR* 6/2), very fine to fine grained, and laminated; quartzite in top 26 ft is very pale orange (10*YR* 8/2), medium to coarse grained, and indistinctly very thin bedded. Quartzite constitutes about 80 percent of lower 30 ft and 20 percent of upper 26 ft. Quartzite in upper 26 ft increases in amount upward and is transitional into quartzite in overlying unit, which it resembles; quartzite in upper 26 ft of unit is in very thin layers interstratified with quartzitic siltstone. Near top of unit, quartzite layers are 2 ft thick. Unit as a whole weathers to form prominent bench and slope	56
7. Quartzite, very pale orange (10*YR* 8/2), minor amount greenish-gray (5*GY* 6/1); weathers pale yellowish brown (10*YR* 6/2); very fine to fine grained; laminated to very thin bedded; stratification slightly irregular in detail; weathers to form cliff. Top 12 ft of unit contains a few very thin to thin layers of dark-greenish-gray (5*GY* 4/1) quartzitic siltstone. Top 2 ft of unit is conglomerate containing granules and pebbles (as large as ½ in.) of quartz set in a coarse-grained to very-coarse grained matrix	60
6. Quartzite to quartzitic siltstone, greenish-gray (5*GY* 6/1), pale-yellowish-brown (10*YR* 6/2), and yellowish-gray (5*Y* 8/1); very fine grained quartzite to coarse-grained quartzitic siltstone; evenly laminated; minor micro-cross-strata (ripple laminae?); weather to form bench. Unit is gradational into over-	

Locality 41—Continued

Providence Mountains section, measured on west side of north-trending ridge about 1½ miles west of Tough Nut Spring, southwestern part sec. 25 (unsurveyed), T. 11 N., R. 13 E.—Continued

	Feet
Stirling Quartzite—Continued	
C member—Continued	
6. Quartzite to quartzitic siltstone, etc.—Con. lying and underlying units across 2–5 ft of strata	28
Total of C member	144
A and B members, undifferentiated:	
5. Quartzite, very pale orange (10*YR* 8/2), pale-yellowish-brown (10*YR* 6/2), rare grayish orange (10*YR* 7/4) and pinkish-gray (5*YR* 8/1); mostly fine to medium grained; some parts that are medium to coarse grained; rare conglomerate layers containing granules and small pebbles (a coarse conglomerate about 15 ft above base of unit contains pebbles as large as 1.1 in.); evenly bedded; very thin to thin beds; weathers to form prominent cliff	160
Total of A and B members, undifferentiated	160
Total of Stirling Quartzite	380
Johnnie Formation:	
4. Quartzitic siltstone, dark-greenish-gray (5*GY* 4/1) to medium-dark-gray (*N*4); coarse silt; dense quartzitic rock; evenly laminated to very thin bedded; weathers to form slope. One or two thin layers of limestone to limy dolomite, similar to that in unit 3, occur from 30 to 36 ft above base of unit. Top 7 ft of unit covered	41
3. Limy dolomite and intraformational conglomerate, light-greenish-gray (5*GY* 8/1), light-gray (*N*7), and moderate-greenish-yellow (10*Y* 7/4); weather light olive gray (5*Y* 6/1); very finely crystalline; laminated to thin bedded; very small amount of intraformational conglomerate which contains flat and rounded fragments of dolomite as large as 5 in. in maximum diameter; greenish parts apparently contain abundant secondary metamorphic minerals. Unit weather to form slope	50
2. Quartzite, yellowish-gray (5*Y* 8/1) to light-greenish-gray (5*GY* 8/1); in part very fine grained, in part very coarse grained; scattered granules and pebbles (as large as ¾ in. in diameter); very thin bedded; possibly some very low angle cross-strata; weathers to form minor ledge. From a distance, this unit is difficult to distinguish from underlying unit. Top 4 ft is dominantly fine-grained quartzite and contains some laminae and very thin beds of greenish-gray (5*GY* 6/1) argillitic siltstone	22
Total of Johnnie Formation	113

Locality 41—Continued

Providence Mountains section, measured on west side of north-trending ridge about 1½ mile west of Tough Nut Spring, south-western part sec. 25 (unsurveyed), T. 11 N., R. 13 E.—Continued

NOTE.—Uncomfortable contact of schist and Johnnie Formation sharp and flat. Schistosity is subparallel to contact, but one quartz vein is truncated along the unconformity.

	Feet
Older Precambrian rocks:	
1. Schist, light-greenish-gray (5*GY* 8/1); weathers light olive gray (5*Y* 6/1); composed of quartz, feldspar, and biotite; coarsely crystalline; well-defined schistosity; weathers to form slope. Schist contains quartz veins that are parallel to schistosity	Unmeasured

Locality 42

Marble Mountains section, measured about 2½ miles northeast of Chambless, north-central part sec. 28, T. 6 N., R. 14 E.

[Measured by J. H. Stewart, October 1964]

	Feet
Chambless Limestone:	
8. Limestone, light-gray (*N*7), very finely crystalline, laminated to thin-bedded; weathers to form cliff; contains common *Girvanella*. Unit about 130 ft thick	Unmeasured
Latham Shale:	
7. Siltstone and minor limestone. Siltstone; same as in unit 5. Limestone, olive-gray (5*Y* 4/1 and pale-yellowish-brown (10*YR* 6/2); weathers moderate yellowish brown (10*YR* 5/4); aphanitic to very finely crystalline; very thin bedded; occurs in 1–10-in. layers interstratified with siltstone. Limestone commonly contains scraps of trilobites. Limestone is absent from basal 10 ft of unit and constitutes about 10 percent of the top 40 ft of unit. Basal 10 ft of unit contains *Paedeumias clarki* Resser in the siltstone (USGS colln. 4639–CO, identified by A. R. Palmer, written commun. 1965)	50
6. Quartzite to silty sandstone, and minor siltstone. Quartzite to silty sandstone, very light gray (*N*8) to light-greenish-gray (5*GY* 8/1), pale-yellowish-brown (10*YR* 6/2), and rare grayish-red (5*R* 4/2), fine- to medium-grained; some coarse grains; some quartzitic parts, some silty and nonquartzitic parts; laminated to thin bedded; occur as 1-in. to 1-ft layers interstratified with siltstone. Siltstone; same as in unit 5. Unit as a whole weathers to form minor ledge	7
5. Siltstone, olive-gray (5*Y* 4/1); fine silt; some mica; platy splitting; weathers to form slope	16
Total of Latham Shale	73
Tapeats Sandstone:	
Strata equivalent to Zabriskie Quartzite:	
4. Quartzite, very light gray (*N*8); weathers pale yellowish brown (10 *YR* 6/2); fine to medium grained; some coarse grains; laminated to very thin bedded; some irregularity in stratification; rare small-scale high-angle cross strata; weathers to form light-colored cliff	73
Total of strata equivalent to Zabriskie Quartzite	73
Strata equivalent to upper member of Wood Canyon Formation:	
3. Siltstone (50 percent) and quartzite (50 percent). Siltstone, dark-greenish-gray (5*GY* 4/1); weathers dusky yellow brown (10*YR* 2/2); coarse silt; micaceous; laminated to thin bedded; platy splitting in places. Quartzite, dark-greenish-gray (5*GY* 4/1) and minor grayish-red (5*R* 4/2); weathers dusky yellow brown (10*YR* 2/2); very fine grained; commonly micaceous; commonly silty; grades into coarse siltstone; laminated; rate small-scale low-angle cross-laminae; occurs as 1–12-in. layers interstratified with siltstone of similar thicknesses. Basal 11 ft of unit contains a few 1-in. to 2-ft layers of fine- to medium-grained quartzite similar to that in unit 2. Top 5 ft of unit is very fine to fine-grained quartzite and is transitional into overlying unit; this 5-ft unit, however, appears to be more similar to unit 3 than to unit 4, so it is included with unit 3. Bedding plane surfaces in unit marked by common cusp(?) ripple marks, microripple marks, trilobite tracks and trails, and rare *Scolithus* tubes. Unit as a whole weathers to form saddle between cliffy units above and below	94
Total of strata equivalent to upper member of Wood Canyon Formation	94
Strata equivalent to middle member of Wood Canyon Formation:	
2. Quartzite and siltstone. Quartzite, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1), minor medium-gray (*N*5) with pink cast, and very pale orange (10 *YR* 8/2); weathers dark yellowish brown (10*YR* 4/2); fine to medium grained; some coarse and very coarse grained parts; minor conglomeratic layers in lower 70 ft of unit with granules and pebbles (as large as 1.2 in.) of quartz and some of jasper and quartzite; composed of thin tabular planar and trough sets of small- and medium-scale high-angle cross-strata. Siltstone, dark-gray (*N*3); fine to coarse silt; some sandy (very fine) parts; mica-	

Locality 42—Continued

Marble Mountains section, measured about 2½ miles northeast of Chambless, north-central part sec. 28, T. 6 N., R. 14 E.—Con.

Tapeats Sandstone—Continued
Strata equivalent to middle member of Wood Canyon Formation—Continued *Feet*
2. Quartzite and siltstone, etc.—Continued ceous; platy splitting; occurs as 1-in. to 2-ft layers interstratified with quartzite. Siltstone constitutes about 10 percent of lower part of unit and increases to about 25 percent at top. Unit as a whole weathers to form cliff. *Scolithus* tubes occur in sandy siltstone at 306 ft above base of unit and rarely in quartzite in top 15 ft of unit. Unit probably cut by a few small faults, with displacements of less than 10 ft---------- 320

Total of strata equivalent to middle member of Wood Canyon Formation---- 320

Total of Tapeats Sandstone----------- 487

Contact of Wood Canyon Formation and gneiss is sharp and flat.
Older Precambrian strata:
1. Gneiss, olive-black (5*Y* 2/1) to grayish-black (*N*2); weathers same colors; medium crystalline to coarsely crystalline; composed of pink orthoclase(?), quartz, and biotite; weathers to form slope---------------------------- Unmeasured

ESMERALDA COUNTY, NEVADA

Locality 44

Weepah Hills No. 2 section, measured starting about 2 miles west of Paymaster Canyon and ending on hillside on west side of Paymaster Canyon. Base of section about 1.3 miles south-southwest of peak marked 7700 on Goldfield 1:250,000 scale map and ends about 1.8 miles S. 34° E. of this peak. Secs. 25 and 26, both unsurveyed, T. 1 N., R. 40 E.

[Measured by J. H. Stewart, October 1961]

Top of section; top of exposure. Top of section is about a mile N. 81° W. of abandoned churn drill.
Emigrant Formation (incomplete):
Limestone and chert member: *Feet*
25. Limestone, medium-dark-gray (*N*4); weathers same color; aphanitic; well indurated; well bedded; beds ½-3 in. thick (some beds separated by grayish-orange bands about ⅛-in. thick); flaggy to slabby; weathers to form ledge with dip slope in upper part. About 50 ft exposed. Some lamination within framework of large beds. No chert noted---------------------- Unmeasured

Shale member:
24. Shale, olive-gray (5*Y* 4/1) to greenish-gray (5*GY* 6/1); weathers same colors; clay

Locality 44—Continued

Weepah Hills No. 2 section, measured starting about 2 miles west of Paymaster Canyon and ending on hillside on west side of Paymaster Canyon. Base of section about 1.3 miles south-southwest of peak marked 7700 on Goldfield 1:250,000 scale map and ends about 1.8 miles S. 34° E. of this peak. Secs. 25 and 26, both unsurveyed, T. 1 N., R. 40 E.—Continued

Emigrant Formation (incomplete)—Continued
Shale member—Continued *Feet*
24. Shale, olive-gray, etc.—Continued and fine silt; very thinly laminated; laminae probably less than 1 mm thick; shaly splitting, excellently developed; exposed on ridge. Shale is locally dusky yellow (5*Y* 6/4) in basal 20 ft, and the top 3 ft is entirely dusky yellow------------------- 244

Total of shale member-------------- 244

Limestone and siltstone member:
23. Siltstone (70 percent) and limestone and silicified limestone(?) (30 percent). Siltstone, light-gray (*N*7), minor amount grayish-red (5*R* 7/2); weathers same colors and grayish orange (10*YR* 7/4); fine silt; well indurated; evenly laminated to thinly laminated; papery splitting. Limestone and silicified limestone(?), medium-gray (*N*5), rare light-olive-gray (5*Y* 6/1); weather same colors and grayish orange (10*YR* 7/4); aphanitic to finely crystalline; well indurated; evenly laminated to thinly laminated; platy. All gradations in lithologic type between three end members: (1) fine-grained siltstone, (2) limestone, and (3) silicified limestone(?). The silicified limestone(?) probably constitutes about 10 percent of unit; it is a cherty rock that is evenly and thinly laminated. The rock types are intricately interbedded. Unit as a whole weathers to form ridge with small ledges developed on limestone units. Some phosphatic(?) brachiopod shells from 197 to 202 ft above base of unit ---------------------------------- 315
22. Limestone, medium-gray (*N*5); weathers same color; aphanitic to very finely crystalline; well indurated; somewhat wavy bedding; beds 1–3 in. thick; weathers to form ledge. Some irregular lenses of pale-yellowish-brown (10*YR* 6/2) limestone occur in unit-------------------------- 7
21. Siltstone, pale-yellowish-brown (10*YR* 6/2), minor amounts medium light gray (*N*6) and pale-red (10*R* 6/2); weathers dominantly pale brown (5*YR* 5/2); coarse silt; possibly some very fine sand; uncommon amount of white mica; well indurated; stratification concealed; weathers to form

Locality 44—Continued

Weepah Hills No. 2 section, measured starting about 2 miles west of Paymaster Canyon and ending on hillside on west side of Paymaster Canyon. Base of section about 1.3 miles south-southwest of peak marked 7700 on Goldfield 1:250,000 scale map and ends about 1.8 miles S. 34° E. of this peak. Secs. 25 and 26, both unsurveyed, T. 1 N., R. 40 E.—Continued

	Feet
Emigrant Formation (incomplete)—Continued	
Limestone and siltstone member—Continued	
21. Siltstone, pale-yellowish-brown, etc.—Con. steep slope covered with talus. Thickness of unit approximate. Some minor faulting	22
Total of limestone and siltstone member	344
Total of incomplete Emigrant Formation	588

NOTE.—Lower part of Emigrant Formation measured starting about a mile S. 78° W. of abandoned churn drill. Section continues along a general N. 70° E. line for about a thousand feet.

	Feet
Mule Spring Limestone:	
20. Limetstone and minor amount of dolomite, medium-gray (*N*5) to medium-light-gray (*N*6), some pale-yellowish-brown (10*YR* 6/2) in lower third; weather same colors; medium crystalline to coarsely crystalline (probably recrystallized by metamorphism); well indurated; crude thin to thick beds; weather to form prominent cliff and dip slope in upper part. A few "*Girvanella*" noted in lowermost part of unit and at scattered horizons elsewhere. At least one brown-weathering siltstone layer, about 10 ft thick, occurs in lower third of unit; other siltstone layers may occur. On cliffs about half a mile north, the lower third of the Mule Spring Limestone is a brown-weathering probably somewhat silty unit; the middle third is a unit of very light gray weathering limestone and brown-weathering silty(?) beds; and the upper third is medium-gray-weathering limestone. A complete and accurate section of the Mule Spring Limestone could probably be pieced together on this outcrop	300–400
Estimated thickness of Mule Spring Limestone	300–400

NOTE.—Top of Harkless Formation along line of section is about a mile S. 87° W. of abandoned churn drill in Paymaster Canyon.

	Feet
Harkless Formation:	
Siltstone member:	
19. Siltstone, pale-brown (5*YR* 5/2); weathers same color; coarse silt; common silt-sized white mica; well indurated; laminated to very thin bedded; weathers to form brown cliff. Commonly contains cubic crystals of limonite after pyrite up to ¼-in. across	7.5

Locality 44—Continued

Weepah Hills No. 2 section, measured starting about 2 miles west of Paymaster Canyon and ending on hillside on west side of Paymaster Canyon. Base of section about 1.3 miles south-southwest of peak marked 7700 on Goldfield 1:250,000 scale map and ends about 1.8 miles S. 34° E. of this peak. Secs. 25 and 26, both unsurveyed, T. 1 N., R. 40 E.—Continued

	Feet
Harkless Formation—Continued	
Siltstone member—Continued	
18. Limestone, medium-gray (*N*5); weathers same color; aphanitic to very finely crytalline; well indurated; faint beds 1–3 in. thick; weathers to form small ledge. No fossils noted	4.0
17. Siltstone (dolomitic?), medium-gray (*N*5) and pale-brown (5*YR* 5/2); weathers pale brown (5YR 5/2); coarse silt; well indurated; dolomitic(?) cement, perhaps some siliceous cement; evenly laminated; weathers to form brown cliff. Small irregular pits and indistinct markings on some bedding planes	27
16. Siltstone, pale-olive (10*Y* 6/2) to grayish-olive (10*Y* 4/2), and dark-greenish-gray (5*GY* 4/1); weathers same colors; fine(?) silt; well indurated; platy; stratification concealed by splitting; weathers to form slope. A few scraps of trilobites in lower 5 ft of unit. Abundant small cubic cavities produced by weathering and removal of pyrite cubes. A few limonite after pyrite cubes occur	161
15. Limestone, medium-dark-gray (*N*4); weathers same color; aphanitic; well indurated; beds 2–4 in. thick; platy to flaggy splitting; weathers to form minor ledge	6.5
14. Siltstone, olive-gray (5*Y* 4/1) to dark-greenish-gray (5*GY* 4/1), minor amount dark-yellowish-brown (10*YR* 4/2); weathers same colors; fine to medium(?) silt; common silt-sized white mica; platy; apparently splits parallel to stratification, although stratification cannot be seen; weathers to form slope. Abundant partial and complete specimens of trilobites in lower 73 ft of unit. (USGS coll. 3701–CO, *Paedeumias nevadensis*? (Walcott), *Ogygopsis*?, *Bonnia* sp., *Macanthopsis*? sp., and undetermined ptychoparoid, identified by A. R. Palmer, written commun., 1962.) Abundant small cubic cavities in siltstone, probably where pyrite cubes have been weathered and removed	83
13. Siltstone, light-gray (*N*5) to very light gray (*N*8) and brownish-gray (5*YR* 4/1); weathers light brownish gray (5*YR* 6/1) to brownish gray (5*YR* 4/1); coarse silt; possibly very fine grained sandstone in places; well indurated; siliceous cement; laminated; platy; splits along laminae; weathers to form small bench. A 1.5-ft limestone bed, similar to limestone in unit	

Locality 44—Continued

Weepah Hills No. 2 section, measured starting about 2 miles west of Paymaster Canyon and ending on hillside on west side of Paymaster Canyon. Base of section about 1.3 miles south-southwest of peak marked 7700 on Goldfield 1:250,000 scale map and ends about 1.8 miles S. 34° E. of this peak. Secs. 25 and 26, both unsurveyed, T. 1 N., R. 40 E.—Continued

Harkless Formation—Continued

Siltstone member—Continued — *Feet*

13. Siltstone, light-gray, etc.—Continued 12, is about 4 ft above base of unit and contains abundant trilobite scraps — 30
12. Limestone, grayish-orange (10*YR* 7/4) to dark-yellowish-brown (10*YR* 4/2), minor amount medium-gray (*N*5); weathers moderate yellowish brown (10*YR* 5/4); aphanitic to finely crystalline; well indurated; indistinctly very thin to thin bedded; weathers to form ledge. Contains a few trilobite scraps about 4 ft above base of unit — 7.0
11. Siltstone, dusky-yellow (5*Y* 6/4); weathers same color; fine(?) silt; well indurated; mostly concealed stratification (by cleavage and fractures); some 2–3-in. beds noted; weathers to form slope. Siltstone contains many small cubic cavities that probably were formed by weathering and removal of pyrite cubes — 95

Offset in section so that overlying units measured about 800 ft S. 55° E. of underlying units. Units 8, 9, 10 are contorted and repeated locally.

10. Limestone; same as unit 8; no definite fossils noted. A few indistinct spherical masses, which could be *"Girvanella,"* were noted — 5.5
9. Siltstone, light-olive-gray (5*Y* 4/2); weathers same color; fine(?) silt; commonly contains silt-sized white mica; well indurated; faint very thin to thin bedding; forms reentrant between two limestone units. Common cubic cavities probably were formed where pyrite weathered from rock — 15.0
8. Limestone, dark-yellowish-brown (10*YR* 4/2); weathers same color; aphanitic; well indurated; faint thin to very thin beds; weathers to form minor ledge. No fossils noted — 4.5
7. Siltstone, grayish-olive (5*Y* 4/2) to pale-olive (10*Y* 6/2), and dark-greenish-gray (5*GY* 4/1); commonly dusky yellow (5*Y* 6/2) in top 250 ft; weathers same colors; fine to medium(?) silt; commonly contains silt-sized white mica; well indurated; fairly well bedded to well bedded in basal 800 ft; beds ½–2 in. thick; laminated in some places; harder more quartzitic(?) layers commonly alternate with less resistant beds; from 800 to 1,759 ft above base of unit bedding is generally 6 in. to several feet thick, and most of the bedding planes have been destroyed by cleavage; unit exposed across crest of range. Most of rock is marked by a

Locality 44—Continued

Weepah Hills No. 2 section, measured starting about 2 miles west of Paymaster Canyon and ending on hillside on west side of Paymaster Canyon. Base of section about 1.3 miles south-southwest of peak marked 7700 on Goldfield 1:250,000 scale map and ends about 1.8 miles S. 34° E. of this peak. Secs. 25 and 26, both unsurveyed, T. 1 N., R. 40 E.—Continued

Harkless Formation—Continued

Siltstone member—Continued — *Feet*

7. Siltstone, grayish-olive, etc.—Continued distinct cleavage at a high angle to bedding. Most pieces of siltstone float are cleavage fragments. Trilobite scraps common in basal 104 ft of unit and from 802 to 839 ft above base of unit. Collection (USGS colln. 3778-CO) mostly from basal 5 ft of unit, but some pieces found as much as 25 ft above base of unit; collection contains *Olenellus* cf. *O. gilberti* Meek, and *Fremontia* cf. *F. fremontia* (Walcott), identified by A. R. Palmer (written commun., 1962). Abundant brachiopod molds from 25 to 30 ft above base of unit. Some surfaces practically covered with brachiopod molds. Two 4–6-in. light-brown limestone beds are about 900 ft above base of section. Several 4–6-in. dark-yellowish-brown (10*YR* 4/2) limestone beds containing abundant *Salterella* occur from 1,206 ft to top of unit. Two light-brown quartzitic siltstone beds, both about a foot thick, are from 1,222 to 1,223 ft and from 2,246 to 2,247 ft above base of unit. Cubic cavities, which are probably holes once filled with pyrite that has weathered out, occur from 1,420 ft to top of unit. Section crosses rhyolite dike about 60 ft wide at 1,532 ft above base of unit. Two limestone beds that are similar to unit 8 occur near top of unit. The lower one is 0.8 ft thick and is 56 ft below the top. The other is a foot thick and is 37 ft below the top of unit — 1,759

Total of siltstone member — 2,205

Quartzitic siltstone member:

6. Quartzitic siltstone (95 percent) and limestone (5 percent). Quartzitic siltstone, dark-greenish-gray (5*GY* 4/1), minor amounts pale-yellowish-brown (10*YR* 6/2) and light-greenish-gray (5*GY* 8/1); weathers dark greenish gray (5*GY* 4/1) and light brown (5*YR* 6/4); coarse silt; commonly contains silt-sized white mica; well indurated; siliceous cement; well bedded; beds ½–3 in. thick; locally laminated; worm borings(?) and irregular markings are common on bedding surfaces. Limestone, grayish-orange (10*YR* 7/4) to light-brown (5*YR* 6/4), minor amount medium-gray (*N*5); weathers same colors; finely crystalline; well indurated; poorly bedded; beds

Locality 44—Continued

Weepah Hills No. 2 section, measured starting about 2 miles west of Paymaster Canyon and ending on hillside on west side of Paymaster Canyon. Base of section about 1.3 miles south-southwest of peak marked 7700 on Goldfield 1:250,000 scale map and ends about 1.8 miles S. 34° E. of this peak. Secs. 25 and 26, both unsurveyed, T. 1 N., R. 40 E.—Continued

Harkless Formation—Continued

Quartzitic siltstone member—Continued — *Feet*

6. Quartzitic siltstone, etc.—Continued
1–3 in. thick; a few laminated parts; 1-in. to 4-ft beds interstratified with the quartzitic siltstone. Bed of limestone from 145 to 149 ft above base of unit contains spherical objects with internal concentric rings, probably "*Girvanella*." Unit as a whole weathers to form blocky slope with some minor ledges. Limestone forms light-colored bands. Unit is more shaly and less quartzitic in top 230 ft and grades into overlying unit. In all, unit contains about 36 ft of limestone — 741

5. Limestone and siltstone. Limestone, medium-gray (*N*5), one interval of very light gray (*N*8); weathers medium gray (*N*5); one yellowish-gray (5*Y* 8/1) interval; finely crystalline to medium crystalline; mostly structureless; some faint very thin to thick beds. Siltstone, pale-yellowish-brown (10*YR* 6/2) to light-brown (5*YR* 6/4), minor amount greenish-gray (5*GY* 6/1); weathers same colors; coarse silt; well indurated; calcareous and probably siliceous cement; beds ½–2 in. thick. Sequences of beds in unit is as follows: 0.0–5.5 ft, limestone; 5.5–12.1 ft, siltstone; 12.1–14.4 ft, limestone; 14.4–27.4 ft, siltstone; and 27.4–77.6 ft, limestone. Top and bottom limestone units contains archeocyathids, most of which are large; the longest noted is 9 in. long, and the widest noted is 3 in. in diameter. The bottom half of the top limestone is very light gray (*N*8) and weathers yellowish gray (5*Y* 8/1). Unit as a whole forms conspicuous yellow-gray cliff — 78

4. Quartzitic siltstone (90 percent) and limestone (10 percent). Quartzitic siltstone, dark-greenish-gray (5*GY* 4/1), light-grown (5*YR* 6/4), and yellowish-gray (5*Y* 7/2); weathers same colors; medium to coarse silt (some very fine sand may be mixed with silt locally); some silt-sized white mica; well indurated; siliceous cement; fairly even bedding; beds generally ½–3 in. thick; commonly laminated; some minute cross-laminae that may be ripple marks. Limestone, which is generally similar to limestone in unit 3, forms two prominent beds: one from 81 to 84 ft and the other from 133 to 147 ft above base of unit. Both beds are fairly massive and contain common to abundant archeocyathids. The archeocyathids. The archeocyathids are ¼–1 in.

Locality 44—Continued

Weepah Hills No. 2 section, measured starting about 2 miles west of Paymaster Canyon and ending on hillside on west side of Paymaster Canyon. Base of section about 1.3 miles south-southwest of peak marked 7700 on Goldfield 1:250,000 scale map and ends about 1.8 miles S. 34° E. of this peak. Secs. 25 and 26, both unsurveyed, T. 1 N., R. 40 E.—Continued

Harkless Formation—Continued

Quartzitic siltstone member—Continued — *Feet*

4. Quartzitic siltstone, etc.—Continued
in diameter and up to 3 or 4 in. long. The rest of the limestone is in 1–6-in. beds interstratified with the siltstone at several positions within the unit. Two 4-in. beds of medium-gray limestone are in top 50 ft of unit. Unit as a whole weathers to form slope covered with debris of quartzitic siltstone — 344

Offset in section so that overlying units measured a few hundred feet S. 55° E. of underlying units.

3. Siltstone and limestone. Siltstone, dark-greenish-gray (5*GY* 4/1) to greenish-gray (5*GY* 6/1), minor amount grayish-olive (5*Y* 4/2); weathers same colors; fine to coarse silt; well indurated; appears to be quartzitic in parts; has calcareous cement in some parts; mostly in beds 1–2 in. thick; some lamination. Limestone, dark-yellowish-brown (10*YR* 4/2) to pale-yellowish-brown (10*YR* 6/2), and minor amount very pale orange (10*YR* 8/2) and pale-olive (10*Y* 6/2); weathers dominantly moderate yellowish brown (10*YR* 5/4); very finely crystalline to finely crystalline; well indurated; mostly very thin bedded; beds ½–2 in. thick; some laminated parts and some thick-bedded parts; bedding indistinct in general. Unit weathers to form ledges. Limestone layers form conspicuous light-colored bands. No fossils noted; locally elsewhere in area archeocyathids occur in limestone beds in this unit. Siltstone commonly contains very thin beds or laminae of brown-weathering calcareous siltstone. Sequence of beds in unit is as follows: 0.0–8.4 ft, siltstone; 8.4–12.9 ft, limestone; 12.9–26.0 ft, siltstone; 26.0–34.2 ft, limestone; 34.2–95.9 ft, siltstone; 95.9–116.0 ft, limestone; 116.0–139.2 ft, siltstone; 139.2–141.5 ft, limestone; 141.5–160.6 ft, siltstone; and 160.6–169.5 ft, limestone — 170

2. Siltstone, grayish-olive (5*Y* 4/2) and dusky-yellow-green (5*GY* 5/2); weathers same colors; fine to coarse silt, probably clay also; well indurated; platy; splits along cleavage; no bedding noted; weathers to form rubble-covered slope. Unit is brighter green than overlying unit and has a bright sheen in the sun. Contact with overlying unit gradational and arbitrary. About 2,00 ft southwest, a "purple pisolite" bed about a foot thick was

Locality 44—Continued

Weepah Hills No. 2 section, measured starting about 2 miles west of Paymaster Canyon and ending on hillside on west side of Paymaster Canyon. Base of section about 1.3 miles south-southwest of peak marked 7700 on Goldfield 1:250,000 scale map and ends about 1.8 miles S. 34° E. of this peak. Secs. 25 and 26, both unsurveyed, T. 1 N., R. 40 E.—Continued

Harkless Formation—Continued

Quartzitic siltstone member—Continued — *Feet*

2. Siltstone, grayish-olive, etc.—Continued noted about 10–20 ft above base of Harkless Formation — 45

Total of quartzitic siltstone member — 1,378

Total of Harkless Formation — 3,583

Poleta Formation:

1. Limestone, medium-gray (*N*5); weathers same color (top 4 ft is light brown (5*YR* 6/4)); aphanitic; beds about ½–2 in. thick; boundaries of beds slightly irregular and wavy; rock in general appears mottled owing to slight mottling of color and irregularity of beds; weathers to form ledgy outcrop. Unit is about 100 ft thick — Unmeasured

Base of section; base of exposure. Base of section is about 1,500 ft east of and over small hill from small cabin and area of many bulldozer cuts.

Locality 45

Weepah Hills No. 1 section, measured north of Clayton Valley about 6 miles east-northeast of The Monocline and 3 miles west of Paymaster Canyon, ¾ mile south of hill 5947, S½ sec. 3 (unsurveyed), T. 1 S., R. 40 E.

[Measured by J. H. Stewart, October 1961]

Top of section; not top of exposure. Section of Harkless Formation (loc. 44) measured about 1½ miles to north.

Harkless Formation: — *Feet*

23. Siltstone, greenish-gray (5*GY* 6/1); weathers same color; fine to medium silt; platy cleavage at angle to stratification; weathers to form minor valley in lower 50 ft and steep slope higher in formation. Lowest carbonate layer in Harkless about 50 ft above base — Unmeasured

Poleta Formation:

Upper member:

22. Limestone, medium-gray (*N*5); in some parts of unit, has interlaminated ⅛–¼-in. discontinuous moderate-yellowish-brown (10 *YR* 5/4); layers that give unit banded appearance in a few places; in top 10 ft of unit, is moderate yellowish brown (10*YR* 5/4); weathers same colors; aphanitic to very finely crystalline;; indistinct beds 1 in. to 2 ft thick; weathers to form prominent cliff. Limestone in one place near base contains limestone pellets 1–3 mm in diameter — 116

Total of upper member — 116

Locality 45—Continued

Weepah Hills No. 1 section, measured north of Clayton Valley about 6 miles east-northeast of The Monocline and 3 miles west of Paymaster Canyon, ¾ mile south of hill 5947, S½ sec. 3 (unsurveyed), T. 1 S., R. 40 E.—Continued

Poleta Formation—Continued

Middle member: — *Feet*

21. Limestone (75 percent) and siltstone to limy siltstone (25 percent). Limestone, pale-yellowish-brown (10*YR* 6/2), light-brown (5*YR* 6/4), and medium-gray (*N*5); weathers dominantly light-brown (5*YR* 6/4); very finely crystalline; irregular beds ½–2 in. thick. Siltstone to limy siltstone, greenish-gray (5*GY* 6/1); weather light greenish gray (5*GY* 8/1) and dark yellowish brown (10*YR* 4/2); medium silt; laminated in parts; stratification mostly obscured by cleavage. Dark-weathering siltstone and limy siltstone are commonly in ⅛–½-in. layers interstratified with light-weathering limestone, producing a light and dark-banded rock. A few layers of siltstone and limy siltstone are 1–8 ft thick. In lower part of unit, light-brown (5*YR* 6/4) dolomite layers ⅛–¼-in. thick occur interstratified with light-colored limestone, also producing a banded rock. The dolomite layers are irregular, and in places the dolomite occurs as irregular stringers and blotches. Unit as a whole weathers to form steep slope with some minor ledges on the thicker limestone layers — 90

20. Silty sandstone, greenish-gray (5*GY* 6/1), and rare pale-yellowish-brown (10*YR* 6/2) and light-olive-gray (5*Y* 5/2); weathers dominantly dusky yellowish brown (10*YR* 2/2); coarse silt to very fine sand (average grain size near boundary of silt and sand); well indurated; probably siliceous cement (quartzitic); evenly laminated in part; mostly in beds 1–8 in. thick; weathers to form dark ledgy unit near top of middle member of Poleta Formation. Contains a few *Scolithus* tubes about ⅜–½-in. in diameter — 23

19. Limestone (60 percent) and siltstone (40 percent). Limestone, pale-yellowish-brown (10*YR* 6/2), moderate-yellowish-brown (10*YR* 5/4), dark-yellowish-brown (10*YR* 4/2), and medium-gray (*N*5); weathers same colors; aphanitic to very finely crystalline; rarely laminated; mostly in beds ½–2 in. thick; layers ½ in. to 14 ft thick interstratified with siltstone. Siltstone, pale-olive (10*Y* 6/2), grayish-olive (10*Y* 4/2), and greenish-gray (5*GY* 6/1); weathers same colors; medium silt; laminated in places; stratification mostly obscured by cleavage at angle to stratification; platy. Siltstone and limestone intricately interstratified in some parts of unit; in other parts, limestone and siltstone are in well-defined units. Much of limestone is mottled owing to intermixing of colors and to slight irregularity in bedding. Prominent medium-gray limestone

Locality 45—Continued

Weepah Hills No. 1 section, measured north of Clayton Valley about 6 miles east-northeast of The Monocline and 3 miles west of Paymaster Canyon, 3/4 mile south of hill 5947, S1/2 sec. 3 (unsurveyed), T. 1 S., R. 40 E.—Continued

Poleta Formation—Continued

Middle member—Continued — *Feet*

19. Limestone (60 percent), etc.—Continued layer from 44 to 52 ft above base of unit. Unit weathers to form steep slope with minor ledges on some limestone layers. Top 22 ft of unit is siltstone and grades into overlying unit. *Holmia* sp. found 20± ft above base of unit (USGS collection 4240–CO, identified by A. R. Palmer, written commun., 1963) — 155
18. Siltstone and limy siltstone (75 percent) and limestone (25 percent). Siltstone and limy siltstone, grayish-olive (10*Y* 4/2), dusky-yellow (5*Y* 6/4), and pale-olive (5*Y* 6/2), and limy siltstone, moderate-yellowish-brown (10*YR* 5/4), light-brown (10*YR* 5/6); and grayish-yellow (5*Y* 8/4); weather same colors; medium silt; rare beds of coarse silt; laminated to very thin bedded; some parts are siltstone, but other parts contain a varying amount of calcite and grade to limestone. Limestone, moderate-yellowish-brown (10*YR* 5/4), pale-yellowish-brown (10*YR* 6/2), dark-yellowish-brown (10*YR* 4/2), and medium-gray (*N*5); weathers same colors; aphanitic to very finely crystalline; some layers are laminated, others are in beds 1–2 in. thick. Limestone is in layers 1/2 in. to 5 ft thick. Prominent limestone units occur from 19 to 22 ft, 42 to 45 ft, 80 to 85 ft and 95 to 98 ft above base of unit; these units are generally mottled with gray and brown colors. Unit as a whole forms steep slope — 127
17. Siltstone (90 percent) and limestone (10 percent); similar to unit 11. Locally siltstone is dark greenish gray (5*G* 4/1) or light brown (5*YR* 6/4) and forms 4–8-in. beds. These beds are well cemented and quartzitic in character. Unit gradational into overlaying unit. Some minor faulting in topmost part of unit — 118
16. Limestone, pale-yellowish-brown (10*YR* 6/2) to moderate-yellowish-brown (10*YR* 5/4), minor amount medium-gray (*N*5); weathers same colors; aphanitic to very finely crystalline; evenly laminated in most places; some very thin beds; weathers to form ridge — 15
15. Siltstone, pale-olive (10*Y* 6/2) to grayish-olive (10*Y* 4/2); weathers same colors; medium silt; laminated; some extremely low-angle cross-strata (may be ripples); weathers to form trench between ridges of units 14 and 16 — 10
14. Limestone, moderate-yellowish-brown (10*YR* 5/4), minor amount medium-gray (*N*5); weathers same colors; aphanitic to very finely crystalline; laminated in part; beds 1/2–2

Locality 45—Continued

Weepah Hills No. 1 section, measured north of Clayton Valley about 6 miles east-northeast of The Monocline and 3 miles west of Paymaster Canyon, 3/4 mile south of hill 5947, S1/2 sec. 3 (unsurveyed), T. 1 S., R. 40 E.—Continued

Poleta Formation—Continued

Middle member—Continued

14. Limestone, moderate-yellowish-brown, etc.—Con. *Feet* in. thick in other parts; weathers to form ridge. Top 2 ft of unit contains some light-brown (5*YR* 6/4) dolomite as 1/2-in.-thick layers and as irregular mottling. Bottom half of unit contains, in places, small conical fossils, 1/8–1/16 in. in diameter, which may be *Hyolithes* — 7
13. Siltstone (85 percent) and limestone (15 percent); similar to unit 11. Some siltstone is pale olive (10*Y* 6/2). Siltstone commonly contains spines and other scraps of trilobites. Limestone is in units from 1 in. to 1 1/2 ft thick. Unit as a whole weathers to form slope. A few linear ripple marks with wavelengths of 1 1/2–2 in. noted. Some limestone beds contain wavy lamination and are perhaps cross-stratified at a low angle locally — 117
12. Limestone, pale-yellowish-brown (10*YR* 6/2) to moderate-yellowish-brown (10*YR* 5/4); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline; beds 1/4–4 in. thick; weathers to form prominent light-colored ridge — 14
11. Siltstone (85 percent) and limestone (15 percent). Siltstone, grayish-olive (5*Y* 4/2) and dusky-yellow-green (5*GY* 5/2); weathers same colors; medium silt; platy cleavage fragments; cleavage obscures bedding. Limestone, moderate-yellowish-brown (10*YR* 5/4) and pale-yellowish-brown (10*YR* 6/2); weathers moderate yellowish brown (10*YR* 5/2); very finely crystalline; 1/2–6-in. beds interstratified with siltstone. Limestone locally contains very poorly preserved *Hyolithes* or *Salterella*. Unit as a whole forms slope — 46

Total of middle member — 722

Lower member:

10. Limestone, medium-light-gray (*N*6) to medium-gray (*N*5); weathers same colors; composed of oolites (no internal structure seen) 1/2–1 mm in diameter set in aphanitic to very finely crystalline matrix (oolites constitute at least 50 percent of any one rock sample; some parts of unit do not appear oolitic and are aphanitic to very finely crystalline; in places, oolites are difficult to distinguish because of shearing and recrystallization of rock); indistinct beds 8 in. to 2 ft thick; weathers to form prominent ridge. Bottom 20 ft of unit is in part grayish orange (10*YR* 7/4), and top 4 ft of unit is very pale orange (10*YR* 8/2) and grayish orange (10*YR* 7/4). Top 4 ft of unit forms inconspicuous light-colored band — 153

Locality 45—Continued

Weepah Hills No. 1 section, measured north of Clayton Valley about 6 miles east-northeast of The Monocline and 3 miles west of Paymaster Canyon, 3/4 mile south of hill 5947, S1/2 sec. 3 (unsurveyed), T. 1 S., R. 40 E.—Continued

Poleta Formation—Continued

Lower member—Continued *Feet*

9. Siltstone (90 percent) and limestone (10 percent). Siltstone, moderate-yellowish-brown (10*YR* 5/4), minor amount pale-olive (10*Y* 6/2); weathers mainly to a chalky yellow gray (5*Y* 8/1) surface; medium silt; papery to platy. Limestone, moderate-yellowish-brown (10*YR* 5/4), very finely crystalline; laminated to very thin bedded 1/2–6-in. sets interstratified with siltstone. Unit as a whole weathers to form step yellowish-gray-weathering slope 39
8. Limestone (95 percent and dolomite (5 percent). Limestone, medium-dark-gray (*N*4), rare very pale orange (10*YR* 8/2), and grayish-orange (10*YR* 7/4); weathers same colors; aphanitic to very finely crystalline; beds 1/2–3 in. thick, some beds up to 4 ft thick. Dolomite, light-brown (5*YR* 6/4); weathers same color; aphanitic to very finely crystalline; occurs as 1/8–1-in. layers interstratified with limestone and as irregular mottles in limestone. Unit as a whole weathers to form lower of two prominent cliffs in lower member of Poleta Formation. Unit contains some minor folds and a few irregular thin dikes. Unit contains a few structures considered to be poorly preserved archeocyathids. Shearing and recrystallization make recognition of fossils difficult 136
7. Siltstone (95 percent) and limestone (5 percent). Siltstone, pale-olive (10*Y* 6/2), minor amount moderate-yellowish-brown (10*YR* 5/4); dominantly grayish olive (10*Y* 4/2) from 96 to 159 ft above base of unit; weathers dominantly same colors, but some parts weather to a chalky yellowish-gray (5*Y* 8/1) surface; medium to coarse silt; platy. Limestone, moderate-yellowish-brown (10*YR* 5/4) to dark-yellowish-brown (10*YR* 4/2); weathers same colors; very finely crystalline; some indistinctly laminated to very thin bedded parts; 1–6-in. sets interstratified with siltstone. Unit as a whole weathers to form step slope. Grayish-olive siltstone from 96 to 159 feet above base of unit contains a few scraps of trilobites(?). Unit cut by a few thin latite(?) dikes near top 159
6. Siltstone, moderate-brown (5*YR* 4/4) to dark-yellowish-brown (10*YR* 4/2); weathers same colors; medium to coarse silt; platy cleavage at angle to bedding (cleavage obscures most of bedding); some very thin beds; forms east side of major valley. Unit contains two beds (2–3 in. thick) of moderate-brown (5*YR* 4/4) very finely crystalline limestone about 40 ft below top. Top of unit placed at west side of 16-ft-wide latite(?) dike. Base of unit 7 at east side of dike 190
5. Covered: forms part of valley 243
4. Limestone (80 percent) and dolomite (20 percent). Limestone, medium-gray (*N*5) to medium-dark gray (*N*4); weathers same color; aphanitic to very finely crystalline; fairly even beds 1/2–2 inches thick. Dolomite, light-brown (5*YR* 6/4); weathers same color; aphanitic to very finely crystalline; 1/8–2-in. layers interstratified with limestone. Dolomite may be alteration of the limestone, perhaps related to tectonic movement and hydrothermal activity in area. Unit as a whole weathers to form ridge in valley floor 143

Total of lower member 1,063

Total of Poleta Formation 1,901

Offset in section so that overlying units measured as extending about 1,000 ft north of underlying units. Top of unit 3 about half a mile N. 25° E. of a cabin. Base of unit 4 about three-fourths of a mile N. 29° E. from the cabin and about 300 ft north of prominent west-trending dike.

Campito Formation (incomplete):

Montenegro Member:

3. Siltstone, pale-greenish-yellow (10*Y* 8/2), pale-olive (10*Y* 6/2), and grayish-olive (10*Y* 4/2); weathers dominantly pale olive (10*Y* 6/2); medium silt; may contain secondary metamorphic minerals; abundant light-brown limonite spots, probably limonite after pyrite; some pseudomorphs of pyrite present; evenly laminated to very thin bedded; irregular platy cleavage; weathers to form broad valley and lower part of hills on west side of major valley. A few 1–4 in. light-brown limestone beds occur in top 100 ft of Montenegro Member. Top 40 ft of unit contains some orange-pink (5*YR* 7/2) siltstone 1,035
2. Siltstone, dark-greenish-gray (5*GY* 4/1), olive-gray (5*Y* 4/1), and medium-dark gray (*N*4), rare parts altered(?) to light-gray (*N*7) and yellowish-gray (5*Y* 8/1); weathers dominantly dark greenish gray (5*GY* 4/1) to olive black (5*Y* 2/1); commonly moderate brown (5*YR* 4/4) on cleavage surfaces; coarse silt; well indurated; quartzitic in part; small amount of calcareous cement in places; stratified, but not well exposed; mostly in beds 3–12 in. thick; weathers to form east side of hills west of valley formed in unit 3. Siltstone has well-developed cleavage at angle to strati-

Locality 45—Continued

Weepah Hills No. 1 section, measured north of Clayton Valley about 6 miles east-northeast of The Monocline and 3 miles west of Paymaster Canyon, ¾ mile south of hill 5947, S½ sec. 3 (unsurveyed), T. 1 S., R. 40 E.—Continued

Campito Formation (incomplete)—Continued

Montenegro Member—Continued — *Feet*

2. Siltstone, dark-greenish-gray, etc.—Continued fication. Some parts of unit contain porphyroblasts 1–3 mm in diameter. Contact with overlying unit indefinite and gradational over 100–150 ft of beds — 1, 096

Total of Montenegro Member — 2, 131

Andrews Mountain Member:

1. Quartzite to quartzitic siltstone, dark-greenish-gray (5*GY* 4/1), olive-gray (5*Y* 4/1), medium-dark-gray (*N*4), pale-brown (5*YR* 5/2), and grayish-orange-pink (5*YR* 7/2); weathers dominantly brownish black (5*YR* 2/1) to black (*N*1), but have some parts that weather light brown (5*YR* 6/4); grade from very fine grained quartzite to coarse-grained quartzitic siltstone; well sorted; well indurated (some parts contain small amount of calcareous cement, but cement is probably mostly siliceous); stratified, but not well exposed; laminated parts noted rarely; most of unit appears to be in beds 3–12 in. thick. Unit weathers to form rubbly surfaced rolling hills. Top of unit not well defined; gradational into overlying unit through 100–200 ft of beds — Unmeasured

Total of incomplete Campito Formation — 2, 131

Base of section; not base of exposure. Probably 1,000 or 2,000 ft of the Andrews Mountain Member is exposed, but the base is not exposed. Member is probably also cut by faults of fairly large displacement.

Locality 47

Clayton Ridge section, measured on west side of Clayton Ridge, sec. 25, T. 2 S., R. 40 E.

[Measured by J. H. Stewart, April 1965]

Deep Spring Formation:

Upper member: — *Feet*

22. Dolomite, medium-gray (*N*5), very finely crystalline to aphanitic, indistinctly thin bedded; weathers to form ledge at top of hill. Basal 5 ft of unit is pale-yellowish-brown (10*YR* 6/2), moderate-yellowish-brown-weathering (10*YR* 5/4), silty(?) laminated dolomite. Thickness of unit uncertain owing to structural complexity of area. Top of unit not exposed; Campito Formation presumed to overlie the unit, but such a stratigraphic succession cannot be demonstrated in area — 70±

Locality 47—Continued

Clayton Ridge section, measured on west side of Clayton Ridge, sec. 25, T. 2 S., R. 40 E.—Continued

Deep Spring Formation—Continued

Upper member—Continued — *Feet*

21. Siltstone to quartzitic coarse siltstone and quartzitic silty very fine grained sandstone, dark greenish gray (5*GY* 4/1) and greenish gray (5*GY* 6/1); yellowish gray (5*Y* 8/1) in top 10 ft; grade from platy-splitting micaceous medium-grained siltstone to quartzitic coarse-grained siltstone and quartzitic silty very fine grained sandstone; probably about half of unit is quartzitic; quartzitic parts are laminated and in 1–12-in. layers interstratified with siltstone. Thickness of unit cannot be measured owing to structural contortion of unit. Eighty feet of the unit was measured in one structural block, but the total thickness of the unit could be much greater, perhaps even several hundred feet. Unit weathers to form dark slope — 80+

Total of upper member — 150+

Middle member:

Offset in section so that unit 21 measured on top of hill about 200 ft north of where unit 20 measured.

20. Limestone; similar to that in unit 18. Weathers to form ledge — 9

19. Poorly exposed limestone to silty limestone (50 percent) and phyllitic siltstone (50 percent). Limestone to silty limestone, moderate-yellowish-brown (10*YR* 5/4) and rare medium-gray (*N*5); weather mostly moderate yellowish brown (10*YR* 5/4); finely crystalline; some silty parts; very thin bedded; occurs in 1–8 ft layers interstratified with phyllitic siltstone. Phyllitic siltstone; similar to that in underlying unit. Unit weathers to form brown slope — 29

18. Limestone and minor phyllitic siltstone. Limestone, medium-gray (*N*5); weathers same color (a few very thin dolomitic layers and lenses weather moderate yellowish brown (10*YR* 5/4); very finely to finely crystalline; oolitic in places; very thin bedded; some laminated parts. Phyllitic siltstone, light-greenish-gray (5*GY* 8/1); fine silt; platy splitting. Most of unit weathers to form ledges; slopes develop on silty parts of unit. Sequence in unit is as follows: 0–3 ft, brown-weathering dolomite; 3–28 ft, limestone with some possible algal structures; 28–45 ft, 80 percent phyllitic siltstone and 20 percent limestone; 45–72 ft, limestone; 72–74 ft, limestone with a few thin phyllitic siltstone layers; 74–87 ft, limestone; 87–95 ft, 60 percent limestone and 40 percent phyllitic siltstone; 95–118 ft, limestone — 118

Locality 47—Continued

Clayton Ridge section, measured on west side of Clayton Ridge, sec. 25, T. 2 S., R. 40 E.—Continued

	Feet
Deep Spring Formation—Continued	
Middle member—Continued	
17. Siltstone and minor dolomitic siltstone, pale-yellowish-brown (10*YR* 6/2) to moderate-yellowish-brown (10*YR* 5/4); weather same colors; coarse silt; laminated; some very fine grained silty sandstone in top foot of unit. Unit weathers to form slope	15
16. Limestone, medium-gray (*N*5); weathers same color (some irregular lenses and mottles weather moderate yellowish brown (10*YR* 5/4) and probably are dolomitic); finely crystalline; possibly some oolitic parts; laminated; weathers to form ledgy outcrop. Top 5 ft of unit is grayish-orange (10*YR* 7/4), possibly silty, limestone; a few very thin layers of siltstone occur in top half of unit	50
15. Quartzite, pale-yellowish-brown (10*YR* 6/2) to yellowish-gray (5*Y* 8/1), minor light-gray (*N*7), very fine to fine-grained, evenly laminated; rare low-angle cross-strata; weathers to form slope	33
14. Limestone to silty limestone, mostly very pale orange (10*YR* 8/2); some medium gray (*N*5); medium-crystalline; laminated; weather to form cream-colored bench	32
13. Limestone and minor dolomite. Limestone, medium-gray (*N*5); weathers same color to light gray (*N*7); finely crystalline; oolitic in places; laminated to thin bedded. Dolomite, light-gray (*N*7); weathers very pale orange (10*YR* 8/2); finely to medium crystalline; mostly structureless. Dolomite occurs dominantly in middle part of unit and may be a replacement of limestone. Some of limestone has cigar-shaped masses of a color different from surrounding rock	95
12. Quartzite (50 percent) and phyllitic siltstone (50 percent). Quartzite, pale-yellowish-brown (10*YR* 6/2), minor medium-gray (*N*5), mostly very fine to fine-grained, rare fine- to medium-grained, evenly laminated; rare very low angle cross-strata. Phyllitic siltstone, medium-gray (*N*5) to greenish-gray (5*GY* 6/1); coarse silt; micaceous. Phyllitic siltstone occurs mostly in lower half of unit and quartzite in upper half, although both rock types occur throughout unit. Unit weathers to form slope. A medium-gray (*N*5) sandy limestone occurs from 21.0 to 21.5 ft above base of unit	28
Offset in section so that unit 12 measured 200 ft southeast of unit 11.	
11. Limestone, medium-gray (*N*5) and common very pale orange (10*YR* 8/2), very finely crystalline; silty in places (silty parts are mostly very pale orange); oolitic in places in top 5 ft; laminated to thin bedded; weathers to form slope. Lower half of unit contains irregular masses (¼–3 in. across) of moderate-yellowish-brown (10*YR* 5/4) dolomite. A few thin layers of coarse siltstone (similar to that in unit 9) occur in top half of unit. Unit forms a dark- and light-banded unit on top of light-colored dolomite of unit 10. Top 1–2 ft of unit weathers moderate-yellowish brown and forms brown band on outcrop	28
10. Dolomite, light-gray (*N*7); weathers very pale orange (10*YR* 8/2); very finely to medium crystalline; laminated in a few places; mostly structureless; weathers to form cliff. Basal 3 ft of unit weathers moderate yellowish brown (10*YR* 5/4) and forms prominent brown band on outcrop. Unit from 3 to 7 ft above base and in top 10 ft contains some sandy (very fine) dolomite	88±
Offset in section on top of unit 9 so that unit 10 is measured 400 ft south of unit 9.	
9. Coarse siltstone, very pale orange (10*YR* 8/2) to pale-yellowish-brown (10*YR* 6/2); coarse silt; rarely grades to very fine grained sandstone; micaceous in places; evenly laminated; weathers to form slope. A few thin layers of siltstone are dolomitic and weather moderate brown (5*YR* 4/4)	40±
Total of middle member	565
Lower member:	
8. Dolomite, light-gray (*N*7) to very light gray (*N*8); weathers pale yellowish brown (10*YR* 6/2); very coarsely to coarsely crystalline; rarely laminated; very thin to thick bedded in places; commonly structureless; weathers to form prominent cliff. Basal 18 ft of unit is mostly light-gray (*N*7) finely crystalline limestone with irregular "pellets," flakes, thin laminae, and thin lenses of dolomite. Thickness of unit uncertain owing to probable small faults across line of section. Thickness measured probably within 30 or 40 ft of true thickness	135±
7. Phyllitic siltstone (50 percent) and limestone (50 percent). Phyllitic siltstone, greenish-gray (5*GY* 6/1); fine to coarse silt; micaceous. Limestone, yellowish-gray (5*Y* 7/2) to light-olive-gray (5*Y* 6/1); weathers grayish orange (10*YR* 7/4); finely crystalline; possibly silty in parts; laminated; possibly some "pellet" structures similar to that in underlying unit; occurs in	

Locality 47—Continued

Clayton Ridge section, measured on west side of Clayton Ridge, sec. 25, T. 2 S., R. 40 E.—Continued

Deep Spring Formation—Continued

Lower member—Continued | *Feet*

7. Phyllitic siltstone (50 percent), etc.—Con. 1-in. to 2-ft layers interstratified with phyllitic siltstone layers of similar thickness. Unit weathers to form slope 40
6. Limestone to silty limestone (85 percent) and phyllitic siltstone (15 percent). Limestone to silty limestone, very pale orange (10*YR* 8/2) to pale-yellowish-brown (10*YR* 6/2), minor light-greenish-gray (5*GY* 8/1) and light-olive-gray (5*Y* 6/1), finely crystalline; commonly have clastic texture with pellets of brown-weathering silty(?) limestone set in limestone matrix (rare intraformational limestone conglomerate); laminated to thin bedded. Phyllitic siltstone, pale-yellowish-brown (10*YR* 6/2) and greenish-gray (5*GY* 6/1); coarse silt; micaceous; occurs in 1–8 in. layers interstratified with limestone. Unit weathers to form slope. Basal 4 ft of unit contains several thin to thick layers of light-brown (5*YR* 5/6)-weathering dolomite; these brown layers form fairly conspicuous color band on outcrop 96
5. Dolomite, light-gray (*N*7); weathers same and very pale orange (10*YR* 8/2); very finely crystalline; laminated to thick bedded; weathers to form ledge. Some intraformational conglomerate with fragments of dolomite as large as 4 in. found in lower 5 ft 35
4. Siltstone to limy or dolomitic siltstone (80 percent) and dolomite (20 percent). Siltstone to limy or dolomitic siltstone, very pale orange (10*YR* 8/2), light-olive-gray (5*Y* 6/1), and pale-yellowish-brown (10*YR* 6/2); mostly coarse silt; laminated; micaceous. Dolomite, medium-gray (*N*5); weathers light olive gray (5*Y* 6/1); finely crystalline; laminated; occurs in 1-in. to 1-ft layers. Unit forms minor reentrant 9
3. Dolomite, light-gray (*N*7) to very pale orange (10*YR* 8/2); weathers latter color; very finely crystalline; laminated in places; mostly thick to very thick bedded; weathers to form cliff. Unit could cross some minor faults, but none were definitely recognized .... 140±
2. Dolomite and sandy dolomite (75 percent), limestone and sandy limestone (20 percent), and phyllitic siltstone (5 percent). Dolomite and sandy dolomite, medium, gray (*N*5) and light-olive-gray (5*Y* 6/1); weather pale yellowish brown (10*YR* 6/2) to light brown (5*YR* 5/6); finely to medium crystalline; commonly contain fine to medium grains of quartz, the grains constituting 25 percent of rock in some samples; indistinctly

Locality 47—Continued

Clayton Ridge section, measured on west side of Clayton Ridge, sec. 25, T. 2 S., R. 40 E.—Continued

Deep Spring Formation—Continued

Lower member—Continued | *Feet*

2. Dolomite and sandy dolomite, etc.—Con. thin bedded. Limestone and sandy limestone, medium-light-gray (*N*6); weather same with some grayish-orange (10*YR* 7/4) parts; very finely to finely crystalline; commonly contain fine grains of quartz; laminated; some indistinct "pellet" structures in places. Phyllitic siltstone, very pale orange (10*YR* 8/2) to pale-yellowish-brown (10*YR* 6/2), and rare medium-gray (*N*5); medium to coarse silt; occurs in ½–3-in. layers .... 52±

Total of lower member .... 507±

Total of Deep Spring Formation .... 1, 222+

Reed Dolomite:

1. Dolomite, very pale orange (10*YR* 8/2); some light gray (*N*7) in top 5 ft; weathers very pale orange (10*YR* 8/2); finely crystalline; indistinctly thick bedded; weathers to form cliff. About 100 ft exposed along line of section. Perhaps about 200 ft exposed 700 ft to north ... Unmeasured

Locality 49

Goldfield Hills section, measured 12 miles south-southwest of Goldfield. Base of section is S. 15° W., 11.5 miles from Goldfield. Top of section is S. 10° W., 12.1 miles from Goldfield. Section measured in two segments: units 1–6 measured in sec. 33, T. 4 S., R. 42 E; unit 7 measured in eastern part sec. 4, T. 5 S., R. 42 E.

[Measured by J. H. Stewart, October 1961]

Top of section; top of rocks in continuous sequence. Overlying rocks are the same as unit 7, but are contorted by many small folds and may be a repeated part of the section.

Emigrant Formation (incomplete):

Limestone and chert member (incomplete): | *Feet*

7. Limestone (80 percent) and chert (20 percent). Limestone, medium-gray (*N*5) to medium-light-gray (*N*6); weathers same colors; aphanitic, rarely very finely crystalline; well indurated; well bedded; beds ½–3 in. thick, probably averaging about 2 in. in thickness. Chert, medium-gray (*N*5); weathers medium gray (*N*5) and dark yellowish brown (10*YR* 4/2); evenly laminated to thinly laminated; laminae well developed. Chert occurs in ⅛–1-in. layers interstratified with limestone and as irregular disc-shaped masses flattened along bedding. The chert commonly grades laterally into limestone and replaces the limestone; most of the chert, if not all, is replacement chert. The laminated character of the

Locality 49—Continued

Goldfield Hills section, measured 12 miles south-southwest of Goldfield. Base of section is S. 15° W., 11.5 miles from Goldfield. Top of section is S. 10° W., 12.1 miles from Goldfield. Section measured in two segments: units 1–6 measured in sec. 33, T. 4 S., R. 42 E.; unit 7 measured in eastern part sec. 4, T. 5 S., R. 42 E.—Con.

Emigrant Formation (incomplete)—Continued

Limestone and chert member (incomplete)—Con. *Feet*

7. Limestone (80 percent), etc.—Continued chert suggests that the limestone originally had this character but that now it is preserved only in the chert. The unit as a whole has a striped appearance because of the layering of limestone and chert. A few layers of intraformational conglomerate (flat pebble conglomerate) occur. These layers consist of disc-shaped pieces of limestone (as large as 3 in. in diameter) set in a calcite matrix. The disc-shaped pieces are generally parallel to the stratification of the unit. In all, intraformational conglomerate probably constitutes about 10 ft of unit. It occurs as 1–3-ft layers at several positions in unit. Unit as a whole weathers to form west-facing ledgy slope. Base of unit is sharp; no gradation or intertonguing with underlying shale noted 610

Total of incomplete limestone and chert member 610

Offset in section so that unit 7 measured about 2,000 ft east of underlying units.

Shale member:

6. Shale, pale-olive (10*Y* 6/2), dusky-yellow (5*Y* 6/4), light olive gray (5*Y* 6/2), and greenish-gray (5*GY* 6/1); weathers same colors with minor amounts of grayish orange (10*YR* 7/4); clay and fine silt(?); papery and shaly splitting; weathers to form broad valley. Thickness of unit cannot be accurately determined .... 792(?)

Total of shale member .... 792(?)

Limestone and siltstone member:

5. Limestone (75 percent), silicified limestone(?) (10 percent), and siltstone (15 percent). Limestone, medium-gray (*N*5), minor medium-light-gray (*N*6) and light-gray (*N*7); weathers same colors; aphanitic to very finely crystalline; well indurated; bedding well defined; beds ½–2 in. thick; common evenly laminated parts. Silicified limestone(?), medium-gray (*N*5); weathers dark yellowish brown (10 *YR* 4/2); evenly laminated to thinly laminated, some parts showing remarkably thin and even laminations; occurs as ¼–8-in. beds interstratified with limestone and possibly to some extent with the siltstone; mostly occurs in top third of unit.

Locality 49—Continued

Goldfield Hills section, measured 12 miles south-southwest of Goldfield. Base of section is S. 15° W., 11.5 miles from Goldfield. Top of section is S. 10° W., 12.1 miles from Goldfield. Section measured in two segments: units 1–6 measured in sec. 33, T. 4 S., R. 42 E.; unit 7 measured in eastern part sec. 4, T. 5 S., R. 42 E.—Con.

Emigrant Formation (incomplete)—Continued

Limestone and siltstone member—Continued *Feet*

5. Limestone (75 percent), etc.—Continued Siltstone, medium-light-gray (*N*6) and pale-red (5*R* 6/2); weathers same colors; fine silt(?) and clay; platy splitting; occurs as 1–10-ft units interstratified with limestone; mostly occurs in middle part of unit. Unit as a whole weathers to form low hills 416
4. Limy siltstone, medium-gray (*N*5), minor pale-yellowish-brown (10*YR* 6/2); weathers pale yellowish brown (10*YR* 6/4); coarse silt; well sorted; well indurated; calcareous; dense; faint even beds 2–6 in. thick; weathers to form slope. Top and bottom contacts not exposed and thickness of unit is not exact .... 17±
3. Siltstone to claystone, olive-gray (5*Y* 4/1); weather same color; clay and fine silt(?); well indurated; platy splitting; weather to form smooth slope. Basal 47 ft of unit contains abundant *Hyolithes* and trilobite remains (see USGS colln. 3559=CO and 3650=CO) identified by A. R. Palmer (written commun., 1961) as *Oryctocephalus*?, *Alekistocare* cf. *A. agnesensis* (Walcott), and *Syspacephalus* 59

Total of limestone and siltstone member 492

Total of incomplete Emigrant Formation .... 1,894(?)

Mule Spring Limestone:

2. Limestone, medium-gray (*N*5) to medium-light-gray (*N*6); weathers same colors; very finely to finely crystalline; well indurated; fairly well developed bedding; beds 3–24 in. thick; shows mottling of rock within beds; no laminated parts noted; blocky splitting; weathers to form minor hill. Most of unit contains "*Girvanella*" which range in size from ⅜ in. to slightly over 1 in. in diameter. Some rock contains as much as 40 percent "*Girvanella*", but generally the rock contains only a few scattered "*Girvanella*" to as much as 20 percent. Probably about three-fourths of unit contains "*Girvanella*", but exact amount is difficult to estimate owing to poor outcrops in some places and to difficulty in seeing "*Girvanella*" in other places 246

Total of Mule Spring Limestone (lowermost part may be missing because of faulting) 246

Locality 49—Continued

Goldfield Hills section, measured 12 miles south-southwest of Goldfield. Base of section is S. 15° W., 11.5 miles from Goldfield. Top of section is S. 10° W., 12.1 miles from Goldfield. Section measured in two segments: units 1–6 measured in sec. 33, T. 4 S., R. 42 E.; unit 7 measured in eastern part sec. 4, T. 5 S., R. 42 E.—Con.

	Feet
Harkless Formation (incomplete):	
1. Siltstone, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1), and pale-red (10*R* 6/2) to grayish-red (5*R* 4/2); weathers dominantly grayish red (5*R* 4/2) and brownish gray (5*YR* 4/1); fine to medium(?) silt; well indurated; platy splitting; weathers to form gently sloping plain below hill developed on Mule Spring Limestone. Most of unit poorly exposed. Common trilobite cephalons and a few complete specimens from 28 to 38 ft below top of unit; a few cephalons elsewhere in unit. Trilobites (USGS colln. 3705–CO) identified as *Paedeumias* sp. by A. R. Palmer (written commun., 1963). Contact with Mule Spring Limestone poorly exposed and may be faulted to some extent. A few small diabase dikes occur near Mule Spring-Harkless contact	38±
Total of incomplete Harkless Formation	38±

Base of section; base of exposure. Base of section about N. 43° E. of Mount Jackson.

Locality 51

Mount Dunfee section, measured on western, northwestern, and central parts of Mount Dunfee, 2–3 miles east-southeast of Gold Point. Measured in segments: units 1–8 measured on west side of Mount Dunfee, west-central part sec. 7 and extending 1,500± ft west of the western boundary of that section, T. 7 S., R. 42 E.; units 9–18 measured on northwest side of Mount Dunfee, southwestern part sec. 6, T. 7 S., R. 42 E.; units 19–28 measured in central part of Mount Dunfee, north-central part sec. 7, T. 7 S., R. 42 E.

[Measured by J. H. Stewart, October 1961; revised May 1963 and April 1965]

Top of section; top of continuous exposures.

	Feet
Deep Spring Formation:	
Upper member:	
28. Dolomite, medium-gray (*N*5); weathers same color; finely crystalline; fairly well bedded; beds 1–6 in. thick; (commonly laminated in these beds, the laminae being slightly irregular, which suggests reworking of sediments and perhaps formation of ripplelike structures); weathers to form prominent cliff. Unit probably near or at top of Deep Spring Formation, although contact of Campito Formation and Deep Spring Formation is everywhere a fault in this area	52±
27. Quartzite, medium-gray (*N*5); light brown (5*YR* 6/4) in top 15 ft; weathers brown-	

Locality 51—Continued

Mount Dunfee section, measured on western, northwestern, and central parts of Mount Dunfee, 2–3 miles east-southeast of Gold Point. Measured in segments: units 1–8 measured on west side of Mount Dunfee, west-central part sec. 7 and extending 1,500± ft west of the western boundary of that section, T. 7 S., R. 42 E.; units 9–18 measured on northwest side of Mount Dunfee, southwestern part sec. 6, T. 7 S., R. 42 E.; units 19–28 measured in central part of Mount Dunfee, north-central part sec. 7, T. 7 S., R. 42 E.—Continued

	Feet
Deep Spring Formation—Continued	
Upper member—Continued	
27. Quartzite, medium-gray, etc.—Continued ish black (5*YR* 2/1), and light brown (5*YR* 6/4) in top 15 ft; very fine grained; grades to coarse silt; well sorted; even beds about 6 in. to 2 ft thick; a few laminated(?) or very thin bedded parts; blocky; weathers to form black ledges. Unit contains a 1-ft light-greenish-gray (5*GY* 8/1) cross-stratified sandstone 10 ft above base. Cross-strata are in thin tabular planar sets and are small scale. Upper contact of unit may be small fault, but the measured thickness of unit is probably nearly correct	93
26. Siltstone (90 percent) and quartzite (10 percent), poorly exposed. Siltstone, grayish-olive (10*Y* 4/2), light-olive-gray (5*Y* 5/2), and dusky-yellow (5*Y* 6/4); weathers same colors; fine to coarse silt; commonly contains white mica; well indurated; platy. Quartzite found in several 1–2-ft beds in basal 20 ft and in a prominent bed from 58 to 62 ft; quartzite in basal 20 ft is pale yellowish brown (10*YR* 6/2), and quartzite from 58 to 62 ft is medium dark gray (*N*4). Quartzite weathers same colors as fresh rock, is very fine grained, is well sorted, is composed of clear quartz, and is laminated to thin bedded. Unit as a whole weathers to form slope with small ledges developed on quartzite units	97
Total of upper member	242±
Middle member:	
25. Limestone and siltstone. Limestone, medium-gray (*N*5), rare grayish-orange (10*YR* 7/4) streaks and blotches; weathers same colors; very finely crystalline to finely crystalline; faint indistinct oolites in some places; definite oolitic limestone from 62 to 65 ft above base of unit and in most of top 45 ft of unit; well indurated; poorly developed bedding; beds generally ½–4 in. thick; some laminated parts. Limestone in upper 45 ft of unit contains many 6–8-in. tabular planar sets of low-angle (10°±) small-scale cross-strata. This part of unit also contains peculiar lens-shaped	

Locality 51—Continued

Mount Dunfee section, measured on western, northwestern, and central parts of Mount Dunfee, 2–3 miles east-southeast of Gold Point. Measured in segments: units 1–8 measured on west side of Mount Dunfee, west-central part sec. 7 and extending 1,500± ft west of the western boundary of that section, T. 7 S., R. 42 E.; units 9–18 measured on northwest side of Mount Dunfee, southwestern part sec. 6, T. 7 S., R. 42 E.; units 19–28 measured in central part of Mount Dunfee, north-central part sec. 7, T. 7 S., R. 42 E.—Continued

Deep Spring Formation—Continued

Middle member—Continued — *Feet*

25. Limestone and siltstone, etc.—Continued masses, 4–6 in. across, distinguished by slight differences in color; these masses are superimposed on stratification, but follow stratification in general. Limestone contains abundant small (2–4 in. across) algal biscuits from 100 to 110 ft above base of unit. Siltstone, pale-olive (10*Y* 6/2) and grayish-olive (10*Y* 4/2); weathers same colors and moderate yellowish brown (10*YR* 5/4); fine to coarse silt; commonly contains white mica; platy. Unit from 192 to 197 ft above base is limy sandstone, the same as that in unit 21. Sequence of lithologic types in unit is as follows: 0–5 ft, siltstone; 5–9 ft, limestone; 9–14 ft, siltstone; 14–65 ft, limestone; 65–68 ft, siltstone; 68–71 ft, limestone; 71–92 ft, siltstone; 92–119 ft, limestone; 119–127 ft, poorly exposed, mostly siltstone; 127–129 ft, limestone; 129–136 ft, siltstone, poorly exposed; 136–138 ft, limestone; 138–146 ft, siltstone, poorly exposed; 146–176 ft, limestone; 176–186 ft, siltstone; 186–188 ft, limestone; 188–192 ft, siltstone; 192–197 ft, limy sandstone; 197–267 ft, limestone — 267

24. Limy sandstone (90 percent) to limestone and dolomite (10 percent). Limy sandstone, yellowish-gray (5*Y* 8/1), very light gray (*N*8), pale-yellowish-brown (10*YR* 6/2), and light-olive-gray (5*Y* 6/1); weathers dark yellowish brown (10*YR* 4/2); very fine grained; well sorted; composed of subround(?) clear quartz grains; contains variable amount of calcite or, less commonly, dolomite (probably all limy sandstone contains at least 25 percent carbonate, and all gradations exist from limy sandstone to almost pure limestone or dolomite); well indurated; well-defined thin laminations; in places laminae are slightly inclined (1°–3°) to general bedding, and small shallow scours occur locally. Limestone and dolomite, medium-gray (*N*5) to very light gray (*N*8); limestone weathers same colors; dolomite weathers moderate yellowish brown (10*YR* 5/4); finely crystalline; well indurated; stratification same as limy sand-

Locality 51—Continued

Mount Dunfee section, measured on western, northwestern, and central parts of Mount Dunfee, 2–3 miles east-southeast of Gold Point. Measured in segments: units 1–8 measured on west side of Mount Dunfee, west-central part sec. 7 and extending 1,500± ft west of the western boundary of that section, T. 7 S., R. 42 E.; units 9–18 measured on northwest side of Mount Dunfee, southwestern part sec. 6, T. 7 S., R. 42 E.; units 19–28 measured in central part of Mount Dunfee, north-central part sec. 7, T. 7 S., R. 42 E.—Continued

Deep Spring Formation—Continued

Middle member—Continued — *Feet*

24. Limy sandstone (90 percent), etc.—Con. stone. Unit as a whole weathers to form cliff — 135

23. Limestone (70 percent), mostly algal limestone, and siltstone (30 percent). Limestone, light-gray (*N*7) to medium-gray (*N*5), some grayish-orange (10*YR* 7/4) streaks and irregular blotches; weathers same colors; aphanitic to very finely crystalline; limestone in all but top 3 ft of unit contains biscuit-shaped algal growths (fig. 30) that reach a maximum size of a foot across and 1½ ft high. Some of the biscuit-shaped masses coalesce to form larger masses with the siltstone. Position and amount of algal material variable along outcrop. Limestone in top 3 ft of unit contains faint beds ½–1 in. thick; no algal growths noted in top 3 ft of unit. Siltstone, pale-olive (10*Y* 6/2); weathers same color; fine silt; platy. Siltstone in 6-in. to 3-ft beds interstratified with the limestone. The limestone projects up into the siltstone in places, and the distribution of limestone and siltstone along outcrop is variable — 17

22. Siltstone, dark-greenish-gray (5*GY* 4/1) and light-olive-gray (5*Y* 5/2); weathers same colors; fine to medium silt; commonly contains white mica; platy; weathers to form slope. A few 1–4-in. quartzite beds occur; quartzite is yellowish gray (5*Y* 8/1) to light greenish gray (5*GY* 8/1), very fine grained, and thinly laminated — 19

21. Limestone (75 percent), siltstone (10 percent), and intraformational conglomerate (15 percent). Limestone, medium-gray (*N*5); weathers same color; very finely crystalline to finely crystalline; poorly defined beds ½–6 in. thick. Siltstone, pale-olive (10*Y* 6/2); weathers same color; fine to medium silt; platy. Intraformational conglomerate, medium-gray (*N*5) to light-gray (*N*7); minor amount grayish-orange (10*YR* 7/2); weathers same colors; composed of flat disc-shaped sandy limestone or limestone fragments set in finely crystalline calcite matrix (matrix sandy in places); fragments are as large

Locality 51—Continued

Mount Dunfee section, measured on western, northwestern, and central parts of Mount Dunfee, 2–3 miles east-southeast of Gold Point. Measured in segments: units 1–8 measured on west side of Mount Dunfee, west-central part sec. 7 and extending 1,500± ft west of the western boundary of that section, T. 7 S., R. 42 E.; units 9–18 measured on northwest side of Mount Dunfee, southwestern part sec. 6, T. 7 S., R. 42 E.; units 19–28 measured in central part of Mount Dunfee, north-central part sec. 7, T. 7 S., R. 42 E.—Continued

	Feet
Deep Spring Formation—Continued	
Middle member—Continued	
21. Limestone (75 percent), etc.—Continued as 8 in. in diameter and 1 in. thick; fragments lie generally parallel to bedding of unit. Intraformational conglomerate is in several 1–2-ft beds in basal 6 ft of unit and in 1-ft bed at top of unit. Siltstone is in a 4-ft bed in middle of unit	23
20. Quartzite, light-brownish-gray (5*YR* 6/1), yellowish-gray (5*Y* 8/1), and pale-yellowish-brown (10*YR* 6/2); weathers dominantly pale yellowish brown (10*YR* 6/2); very fine to fine grained; well sorted; composed of subrounded to rounded clear quartz grains; some evenly laminated parts; 2–6-in. shallow trough sets of low-angle (2°–10°) small-scale cross-strata in some parts (cross-strata are a conspicuous part of unit); weathers to form minor ledge	13
19. Siltstone (80 percent) and quartzite (20 percent). Siltstone, dark-greenish-gray (5*GY* 4/1) to olive-gray (5*Y* 4/1); weathers same colors; coarse silt to very fine sand; some fine silt; abundant white mica; thinly laminated to laminated; platy to flaggy splitting. Quartzite, yellowish-gray (5*Y* 8/1) to light-greenish-gray (5*GY* 8/1); weathers same colors and light brownish gray (5*YR* 6/1); very fine grained; well sorted; composed of clear quartz; thinly laminated; even and well-defined laminae; a few 4–8-in. tabular planar(?) sets of high-angle (20°) small-scale cross-strata in quartzite in top 30 ft of unit; cross-strata dip generally northwest. Quartzite is in 2-in. to 4-ft sets interstratified with the siltstone. Unit as a whole weathers to form steep slope with minor ledges on quartzite. Lowest strata in unit are in contact with an olive-gray diabase dike (Tertiary?) and are exposed in canyon	112+
Total of middle member	586+

Offset in section so that unit 19 measured about 1,000 ft southeast of unit 18. No outcrops in which strata are continuously exposed from unit 18 to unit 19 are known, but probably few, if any, strata are missing.

	Feet
Lower member:	
18. Dolomite, medium-gray (*N*5) to light-olive-gray (5*Y* 6/1); weathers light brownish gray (5*YR* 6/1), medium crystalline to coarsely crystalline; indistinct slightly wavy laminae; weathers to form ledge. Unit highly faulted, and thickness impossible to determine precisely	100(?)
17. Limestone (75 percent), siltstone (22 percent), and quartzite (3 percent). Limestone, medium-gray (*N*5) and rare yellowish-gray (5*Y* 8/1); weathers same colors; finely crystalline; about 10 percent of the limestone contains very fine subangular grains of quartz; in basal 50 ft a few beds of limestone contain rounded medium grains of quartz; quartz grains constitute as much as 50 percent of rock in extreme case; limestone is well indurated; well bedded; beds ½–3 in. thick; evenly laminated to thinly laminated parts are common; low-angle cross-strata occur rarely; a 4-ft bed of contorted strata (penecontemporaneous) occurs in limestone in middle part of unit. Also near middle of unit is a 50-ft-thick limestone layer containing rod-shaped structures about 1–5 mm long and 1 mm in diameter; some of these structures are also found in limestone in the top 50 ft of the unit. Red limestone pellets, similar to those in unit 16, occur in a few limestone layers in top 30 ft of unit. Siltstone, light-olive-gray (5*Y* 5/2) to olive-gray (5*Y* 3/2), and moderate-yellowish-brown (10*YR* 5/4); weathers same colors; common to abundant white mica; stratification concealed; platy. Quartzite, pale-yellowish-brown (10*YR* 6/2); weathers same color; very fine grained; well indurated; siliceous cement; evenly laminated to thinly laminated. Siltstone is in very thin beds to beds as thick as about 10 ft. Quartzite is in 1–2-ft beds that are mostly interstratified with the siltstone. The limestone is in beds 1–50 ft thick. Unit as a whole weathers to form steep slope containing minor ledges	390±

Offset in section so that unit 17 measured about 700 ft southeast of unit 16.

16. Limestone, very light gray (*N*8) with grayish-red (10R 4/2) pellets; weathers pale yellowish brown (10*YR* 6/2); consists of

Locality 51—Continued

Mount Dunfee section, measured on western, northwestern, and central parts of Mount Dunfee, 2–3 miles east-southeast of Gold Point. Measured in segments: units 1–8 measured on west side of Mount Dunfee, west-central part sec. 7 and extending 1,500± ft west of the western boundary of that section, T. 7 S., R. 42 E.; units 9–18 measured on northwest side of Mount Dunfee, southwestern part sec. 6, T. 7 S., R. 42 E.; units 19–28 measured in central part of Mount Dunfee, north-central part sec. 7, T. 7 S., R. 42 E.—Continued

Deep Spring Formation—Continued

Lower member—Continued *Feet*

16. Limestone, very light gray, etc.—Continued irregular, generally rounded grayish-red pellets 1–3 mm in diameter set in very light gray aphanitic to very finely crystalline matrix (pellets constitute 30–40 percent of rock); faint beds 4–8 in. thick; weathers to form ledge and caps part of hill where section measured ___ 11±
15. Dolomite and limestone. Dolomite; same as that in unit 12. In top 3 ft, this dolomite is dark yellowish orange (10*YR* 7/4) weathers same color) and is aphanitic to very finely crystalline. Limestone, medium-gray (*N*5) to medium-light-gray (*N*6); weathers same colors; aphanitic to finely crystalline; fairly well bedded; beds ½–6 in. thick; some evenly laminated to thinly laminated parts; some parts contain indistinct irregular spherical pellets(?) 1–2 mm across or disc-shaped pellets(?) about 10 mm in diameter and 1 or 2 mm thick—these pellets weather out as lighter colored masses. Unit as a whole weathers to form light- and dark-banded cliff and, with unit 16, caps hill where section was measured. Sequence of beds in unit is as follows: 0–45 ft, dolomite; 45–76 ft, limestone; 76–84 ft, dolomite; 84–108 ft, limestone; and 108–111 ft, dolomite ___ 111
14. Limestone, medium-gray (*N*5) and minor amount light-gray (*N*7); weathers same colors; very finely crystalline to medium crystalline; well indurated; beds 1–12 in. thick, no well-defined bedding; weathers to form ledgy slope. A 2-ft bed, 25± ft below top of unit, is dark-yellowish-orange (10*YR* 7/4) limestone composed of pisolites 1–3 mm in diameter set in a very finely crystalline to finely crystalline calcite matrix. Unit contains several 1–6 in. beds of light-olive-gray (5*Y* 5/2) fine textured micaceous siltstone. Siltstone beds occur in several places throughout unit. Top contact is placed at change from limestone below to dolomite above. Limestone in top 1½ ft of unit changes laterally along outcrop into dolomite ___ 48
13. Siltstone to limy siltstone, pale-yellowish-brown (10*YR* 6/2) to light-olive-gray (5*Y* 5/2) weather same colors; coarse

Locality 51—Continued

Mount Dunfee section, measured on western, northwestern, and central parts of Mount Dunfee, 2–3 miles east-southeast of Gold Point. Measured in segments: units 1–8 measured on west side of Mount Dunfee, west-central part sec. 7 and extending 1,500± ft west of the western boundary of that section, T. 7 S., R. 42 E.; units 9–18 measured on northwest side of Mount Dunfee, southwestern part sec. 6, T. 7 S., R. 42 E.; units 19–28 measured in central part of Mount Dunfee, north-central part sec. 7, T. 7 S., R. 42 E.—Continued

Deep Spring Formation—Continued

Lower member—Continued *Feet*

13. Siltstone to limy siltstone, etc.—Continued silt; some very fine sand; abundant white mica; moderately indurated to well indurated; calcareous cement in part; laminated to thinly laminated; platy; weather to form slope. Sharp lower contact; grade upward into overlying unit ___ 10

Total of lower member ___ 670±

Total of Deep Spring Formation ___ 1,498±

Reed Dolomite:

Upper member:

12. Dolomite, medium-gray (*N*5) to very light gray (N8), and yellowish-gray (5*Y* 8/1); weathers grayish orange (10*YR* 7/4) to very pale orange (10*YR* 8/2); very finely crystalline to finely crystalline; some coarsely crystalline parts; well indurated; faint bedding; beds 6 in. to 2 ft thick; a few laminated parts; weathers to form steep ledgy slope ___ 187
11. Dolomite (70 percent) and limestone and sandy limestone (25 percent). Dolomite, very pale orange (10*YR* 8/2), grayish-orange (10*YR* 7/4), and pale-yellowish-brown (10*YR* 6/2), with pale-yellowish-orange (10*YR* 8/2) films along fractures; weathers grayish orange (10*YR* 7/4) to very pale orange (10*YR* 8/2); finely crystalline to very coarsely crystalline; well indurated; faint beds 6 in. to 2 ft thick; a few laminated parts. Limestone and sandy limestone, medium-gray (*N*5); weather same color; finely crystalline; commonly contain as much as 40 percent very fine subangular quartz grains scattered through limestone; well indurated; fairly well bedded; beds ½–6 in. thick; some laminated parts. Limestone is in 2–15-ft beds interstratified with the dolomite; most of the limestone is in the lower half. Basal limestone unit about 10 ft thick. Limestone apparently grades laterally into dolomite locally. Some of the limestone has faint indications of pisolitic structure similar to that in lower member of Reed Dolomite. Unit as a whole weathers to form steep ledgy slope. Thick-

Locality 51—Continued

Mount Dunfee section, measured on western, northwestern, and central parts of Mount Dunfee, 2–3 miles east-southeast of Gold Point. Measured in segments: units 1–8 measured on west side of Mount Dunfee, west-central part sec. 7 and extending 1,500± ft west of the western boundary of that section, T. 7 S., R. 42 E.; units 9–18 measured on northwest side of Mount Dunfee, southwestern part sec. 6, T. 7 S., R. 42 E.; units 19–28 measured in central part of Mount Dunfee, north-central part sec. 7, T. 7 S., R. 42 E.—Continued

	Feet
Reed Dolomite—Continued	
Upper member—Continued	
11. Dolomite (70 percent), etc.—Continued ness of unit uncertain owing to some faulting; lithologic character of unit may change from mostly dolomite in places to dolomite and minor amounts of limestone in other places	115±
Total of upper member	302±

Offset in section so that overlying units measured about 1,500 ft north of underlying units.

	Feet
Hines Tongue:	
10. Dolomite to sandy dolomite (60 percent), dolomitic sandstone to quartzite (30 percent), and siltstone (10 percent). Dolomite to sandy dolomite, medium-gray (*N*5) to pale-yellowish-brown (10*YR* 6/2), medium-crystalline; commonly contain very fine to fine grains of quartz and grade into dolomitic sandstone; evenly laminated; rare small-scale cross-strata. Dolomitic sandstone to quartzite, very pale orange (10*YR* 6/2), mostly very fine grained; some fine-grained quartzite; commonly micaceous; grade from dolomitic sandstone to vitreous quartzite; laminated; commonly platy. Siltstone, yellowish-gray (5*Y* 7/2) to pale-yellowish-brown (10*YR* 6/2); fine to coarse silt; micaceous; platy; some coarse siltstone is gradational into silty very fine grained sandstone. Lithologic types interstratified in layers 1 in. to 10 ft thick. Unit forms slope and weathers a distinct yellowish brown. Exact thickness not determinable; a questionable 75 ft measured, but unit may be about 100 ft thick and possibly thicker	100(?)
Total of Hines Tongue	100(?)
Lower member:	
9. Dolomite and very small amount of silty dolomite. Dolomite, light-gray (*N*7); weathers same color and medium gray (*N*5); medium to coarsely crystalline; distinct thin to thick beds; rare small-scale cross-strata. Silty dolomite, pale-yellowish-brown (10*YR* 6/2) to moderate-yellowish-brown (10*YR* 5/4); weathers latter color; finely crystalline; fine to coarse silt; laminated; platy; 6-in. to possibly 4-ft layers interstratified with dolomite. One sandy (fine quartz grains) dolomite noted in interval from 10 to 13 ft above base of unit, and some moderate-yellowish-brown (10*YR* 5/4) siltstone noted from 38 to 42 ft above base of unit. Prominent silty dolomite layers in following positions: 0–7 ft, 10–13 ft, and 38–42 ft above base of unit and in top few feet of unit; silty dolomite probably occurs elsewhere in unit, however. Rocks weather to form ledgy well-bedded sequence at top of cliff	130
8. Dolomite, very light gray (*N*8) to medium-light-gray (*N*6) and yellowish-gray (5*Y* 8/1); weathers same colors; finely to coarsely crystalline; that part of unit from 212 to 241 ft above base is composed of pisolites(?) ranging in size from 3 to 6 mm and set in finely crystalline matrix; that part of unit from 304 to 372 ft above base contains indistinct oolites and pisolites similar to those in unit 6 and also includes some vague elliptical structures about 1–2 in. across; dolomite is well indurated; is mostly structureless to thick bedded; has some evenly laminated parts 5–10-ft thick, has a very few tabular planar sets (about 6–8 in. thick) of low-angle (3°–5°) cross-strata associated with laminated dolomite. Lower half of unit contains two or three 4-ft-thick units of intraformational(?) breccia containing blocks of dolomite up to 8 in. across; could be tectonic breccia, but no evidence of faulting noted. A few sandy (very fine quartz grains) dolomite layers, as much as a foot thick, occur from 284 to 304 ft above base of unit. Unit weathers to form cliff	453
7. Dolomite, very pale orange (10*YR* 8/2); minor amount light gray (*N*7) in top part; weathers same colors; aphanitic to finely crystalline; well indurated; structureless; weathers to form light-colored slope. Top 26 ft of unit commonly contains sandy dolomite. Sandy dolomite, medium-light-gray (*N*6) to pale-yellow-	

Locality 51—Continued

Mount Dunfee section, measured on western, northwestern, and central parts of Mount Dunfee, 2–3 miles east-southeast of Gold Point. Measured in segments: units 1–8 measured on west side of Mount Dunfee, west-central part sec. 7 and extending 1,500± ft west of the western boundary of that section, T. 7 S., R. 42 E.; units 9–18 measured on northwest side of Mount Dunfee, southwestern part sec. 6, T. 7 S., R. 42 E.; units 19–28 measured in central part of Mount Dunfee, north-central part sec. 7, T. 7 S., R. 42 E.—Continued

Reed Dolomite—Continued

Lower member—Continued	Feet
7. Dolomite, very pale orange, etc.—Continued ish-brown (10*YR* 6/2); weathers grayish orange (10*YR* 7/4); contains 0–50 percent fine to medium (rarely coarse) subrounded quartz grains set in very finely crystalline to medium-crystalline matrix; laminated 1-in. to 4-ft layers interstratified with dolomite	189
6. Dolomite, very light gray (*N*8) to medium-gray (*N*5), and yellowish-gray (5*Y* 8/1); weathers same colors; medium-crystalline to coarsely crystalline; top 170 ft of unit contains many layers of poorly preserve oolites and pisolites ranging in size from 1 to 5 mm, some showing concentric rings; a few thin layers containing irregular spherical and elliptical masses up to 2 in. across; well indurated; in basal 222 ft, structureless; in upper 170 ft, indistinctly bedded; beds 1–3 in. thick; weathers to form steep cliff. Irregular spherical and elliptical masses, as well as oolites and pisolites, could be algal structures. Contact of Reed Dolomite and Wyman Formation appears conformable. Units 4 and 5 of Wyman Formation are essentially transitional into Reed Dolomite	392
Total of lower member	1,164
Total of Reed Dolomite	1,566

Wyman Formation (incomplete):

5. Siltstone (40 percent), sandy limestone (40 percent), and limestone (20 percent). Siltstone; same as that in units 1 and 2; light brown (5*YR* 6/4) in the first few feet below limestone beds and in top 6 ft of unit. Sandy limestone; same as that in unit 1; evenly laminated; interlayered in layers ¼–6 in. thick with siltstone. Limestone, light-gray (*N*7) to medium-gray (*N*5); weathers same colors; finely to coarsely crystalline; most beds contain spherical and ellipsoidal pisolites from 1 mm to a maximum of 3 cm in diameter, many showing concentric rings; limestone is in beds 6 in. to 4 feet thick interstratified with the rest of unit. In all about six beds of limestone were found, and these beds account for about 15 ft of thickness of unit. Unit as a whole weathers to form slope with minor ledges on limestone	214

Locality 51—Continued

Mount Dunfee section, measured on western, northwestern, and central parts of Mount Dunfee, 2–3 miles east-southeast of Gold Point. Measured in segments: units 1–8 measured on west side of Mount Dunfee, west-central part sec. 7 and extending 1,500± ft west of the western boundary of that section, T. 7 S., R. 42 E.; units 9–18 measured on northwest side of Mount Dunfee, southwestern part sec. 6, T. 7 S., R. 42 E.; units 19–28 measured in central part of Mount Dunfee, north-central part sec. 7, T. 7 S., R. 42 E.—Continued

Wyman Formation (incomplete)—Continued

4. Limestone and dolomite, very light gray (*N*8) to medium-light-gray (*N*6); weather same colors; coarsely to finely crystalline. Top half of unit contains spherical pellets(?), 1–5 mm in diameter, which constitute from a few percent to 20 percent of rock; top half of unit also contains faint traces of pisolites (algal?) up to about 2 mm in diameter. Lower 10 ft of unit is thick bedded, middle third is laminated to very thin bedded, remainder does not contain discernible bedding. Dolomite is in basal 10 ft; rest of unit is limestone. Unit weathers to form light-colored cliff. In places along outcrop, unit is entirely light brown (probably entirely dolomite)	47
3. Siltstone (70 percent) and sandy limestone (30 percent). Siltstone; similar to siltstone in units 1 and 2. Sandy limestone; similar to that in unit 1; evenly laminated to very thin bedded; ½–6-in. beds interstratified with siltstone; grades from almost pure limestone to limy quartzitic siltstone to sandstone. Much of rock shows fine interbedding of limestone, of sandy limestone, and to a lesser extent of limy quartzitic siltstone and sandstone. A few minute cross-laminations that are probably cross sections of ripple marks are found locally. Unit as a whole weathers to form slope. Siltstone in top 10 ft is light brown	326
2. Siltstone, dark-greenish-gray (5*GY* 4/1) to olive-gray (5*Y* 4/1); weathers same colors; fine to coarse silt; some white mica; platy; weathers to form slope. A few sandy limestone beds in top half; grades up into overlying unit	133
1. Siltstone (75 percent) and sandy limestone (25 percent). Siltstone, medium-gray (*N*5) to olive-gray (5*Y* 4/1) to dark-greenish-gray (5*GY* 4/1); weathers same colors; coarse(?) silt; some very fine grained dark-green mica; some indication of even lamination; platy. Sandy limestone, light-gray (*N*7) to medium-gray (*N*5); weathers moderate yellowish brown (10*YR* 5/4); composed of very fine grains (mostly quartz) set in very finely crystalline calcite matrix (sand grains are well sorted and constitute 50 percent of the rock in most places; locally limestone is almost pure); well indurated; evenly laminated; slabby; 2–8-in. layers interstratified with siltstone. Unit as a whole weathers to form slope. Unit contains a	

Locality 51—Continued

Mount Dunfee section, measured on western, northwestern, and central parts of Mount Dunfee, 2–3 miles east-southeast of Gold Point. Measured in segments: units 1–8 measured on west side of Mount Dunfee, west-central part sec. 7 and extending 1,500± ft west of the western boundary of that section, T. 7 S., R. 42 E.; units 9–18 measured on northwest side of Mount Dunfee, southwestern part sec. 6, T. 7 S., R. 42 E.; units 19–28 measured in central part of Mount Dunfee, north-central part sec. 7, T. 7 S., R. 42 E.—Continued

	Feet
Wyman Formation (incomplete)—Continued	
1. Siltstone (75 percent), etc.—Continued few 1–6-in. beds of dark-greenish-gray quartzitic siltstone and very fine grained sandstone	246
Total of incomplete Wyman Formation	966

Base of section; base of strata that appear to be unfaulted. More outcrops to southwest, but may be repetition of strata measured. Base of section at prominent rhyolite dike. Base of section is about 1½ miles S. 56° E. of Gold Point.

Locality 52

Northeast of Mount Dunfee section, measured 5 miles N. 75° E. of Gold Point, NE¼ sec. 33 and NW¼ sec. 34, T. 6 S., R. 42 E.

[Measured by J. H. Stewart, Sept. 15 and 16, 1962]

Top of section at major wash where continuity of section becomes dubious. Section ends near contact with tuff to east.

	Feet
Harkless Formation (incomplete):	
24. Siltstone (90 percent) and sandstone (10 percent). Siltstone, light-brown (5*YR* 6/4), dusky-yellow (5*Y* 6/4), and light-olive-gray (5*Y* 5/2); weathers same colors; fine to coarse silt; abundant silt-size white mica; platy splitting. Sandstone, light-brown (5*YR* 6/4) and minor grayish-red (5*R* 4/2); weathers same colors; very fine grained; abundant coarse silt in some parts; grain size near boundary of coarse silt and very fine sand in some parts; evenly laminated; platy splitting; occurs as 1–6-in. sets interstratified with siltstone. Unit weathers to form rolling hills. Exact thickness of unit exposed difficult to measure, but 300± ft must be fairly close. Some of sandstone beds contain trilobite spines	300±
23. Sandstone, light-brown (5*YR* 6/4) and minor pale-red (5*YR* 6/2) to grayish-red (5*R* 4/2); weathers same colors; very fine grained; grain size near boundary of coarse silt and very fine sand in some parts; well indurated; siliceous cement; indistinctly laminated to very thin bedded; platy to slabby splitting; weathers to form hogback. Thickness not accurate because dip slope on east side of hogback and uncertain dips make measurements uncertain	90±
22. Siltstone to silty sandstone, pale-yellowish-brown (10*YR* 6/2), light-brown (5*YR* 6/4), and grayish-red (5*R* 4/2); weather same colors; abundant white mica; irregularly laminated to very thin bedded in places (stratification concealed in much	

Locality 52—Continued

Northeast of Mount Dunfee section, measured 5 miles N. 75° E. of Gold Point, NE¼ sec. 33 and NW¼ sec. 34, T. 6 S., R. 42 E.—Continued

	Feet
Harkless Formation (incomplete)—Continued	
22. Siltstone to silty sandstone, etc.—Continued of unit); platy to slabby splitting; fine- to coarse-grained siltstone mostly in lower half of unit; much of rock in upper half of unit is sandy siltstone and silty sandstone with a grain size near boundary of coarse silt and very fine sand; a few thin beds of sandy siltstone and silty sandstone occur in lower half of unit. Unit contains a few thin beds of quartzitic fine- to medium-grained sandstone in top half of unit. Unit weathers to form steep slope. Grades into overlying unit. Unit 22 is much different from typical lower quartzitic part of Harkless Formation. The unit is not quartzite except for a few thin beds, is not the greenish-gray color of the lower part of typical Harkless, and weathers to form a slope rather than a ledgy outcrop as does the lower part of the Harkless	181
21. Limestone, moderate-yellowish-brown (10*YR* 5/4); weathers same color; aphanitic to medium crystalline; vague and irregular very thin beds; weathers to form small ledge. Abundant cross sections of trilobites?	1±
20. Siltstone, pale-brown (5*YR* 5/2) and light-olive-gray (5Y 5/2); weathers same colors; fine to medium silt; abundant silt-sized white mica; shaly splitting; weathers to form slope	29
19. Limestone, grayish-red (5*R* 4/2); weathers moderate yellowish brown (10*YR* 5/4); composed of irregular pellets and rounded grains of limestone set in aphanitic limestone matrix; irregularly laminated; weathers to form small ledge	1
18. Siltstone; same as unit 16	13
17. Limestone and sandy limestone, grayish-red (5*R* 4/2) and minor light-brown (5*YR* 6/4); weather dominantly moderate brown (5*YR* 3/4); composed of round limestone grains ½–2 mm across (probably oolites although no interval structure seen) set in aphanitic limestone matrix; contains well-rounded medium to very coarse quartz grains in much of rock; about 50 percent quartz grains in some parts; irregularly laminated; weather to form small ledge	2
16. Siltstone, light-olive-gray (5*Y* 5/2), pale-olive (10*Y* 6/2), and grayish-red (5*R* 4/2); weathers same colors; fine silt and clay; abundant silt-sized white mica; shaly splitting; weathers to form slope	74
15. Limestone, grayish-red (5*R* 4/2) and moderate-yellowish-brown (10*YR* 5/4); weathers same colors; composed of round, elliptical, and irregularly shaped fragments $\frac{1}{16}$–¼ in. across set in finely to medium-crystalline matrix (fragments constitute at least 50 percent of rock; some fragments contain concentric bands and are pisolites); contains some cross sections of trilobites; laminated; some laminae or sets of laminae are slightly wavy and inclined in places at 2°–3° to bedding. Unit weathers to form small ledge	2

Locality 52—Continued

Northeast of Mount Dunfee section, measured 5 miles N. 75° E. of Gold Point, NE¼ sec. 33 and NW¼ sec. 34, T. 6 S., R. 42 E.—Continued

Harkless Formation (incomplete)—Continued — *Feet*

14. Siltstone, pale-olive (10*Y* 6/2), grayish-olive (10*Y* 4/2), and dusky-yellow (5*Y* 6/4); weathers same colors; fine silt and clay; shaly splitting; weathers to form small valley — 35

Total of incomplete Harkless Formation — 728±

Poleta Formation (incomplete):

Upper member:

13. Limestone, medium-gray (*N*5); rarely light olive gray (5*Y* 6/1) in lower 20 ft; weathers same colors, finely to medium crystalline; indistinct beds ½–3 in. thick; slight waviness to beds in places; lower 50 ft contains some evenly laminated parts and also some cross-laminae dipping 2°–3° to bedding; much of limestone has mottled appearance with patches of limestone of slightly different values of gray; a few beds in middle of unit contain abundant "pellets" of limestone from ⅛–¼ in. in diameter. Unit weathers to form prominent hogback — 108

Total of upper member — 108

Middle member:

12. Siltstone to silty limestone, moderate-yellowish-brown (10*YR* 5/4) and pale-red (10*R* 6/2), most limy parts are medium gray; weather same colors; some fine silt to clay parts, some medium to coarse silt parts; all gradations from siltstone and limy siltstone to silky limestone; indistinct lamination; mostly platy splitting; weather to form steep slope with minor ledges. Unit grades into overlying unit over 10–15 ft of beds — 39

11. Sandstone (75 percent), siltstone (20 percent?), and limestone (5 percent). Sandstone, pale-brown (5*YR* 5/2), light-brown (5*YR* 6/4), and very pale orange (10*YR* 8/2); weathers same colors and grayish brown (5*YR* 3/2); mostly very fine grained, partly fine grained (grain size mostly near boundary of coarse silt and very fine sand, difficult to distinguish from siltstone in much of unit); well indurated; calcareous cement in places, siliceous cement in other places; thinly laminated to laminated; rare contorted layers and perhaps some cross-strata; platy to slabby splitting. Siltstone, pale-brown (5*YR* 5/2), moderate-red (5*R* 5/4), and olive-gray (5*Y* 4/1); weathers same colors; fine silt to clay in places, coarse silt grading to very fine sand in in other places; mostly shaly splitting. Limestone, medium-dark-gray (*N*4), minor pale-brown (5*YR* 5/2); weathers same colors; finely to medium crystalline; laminated to

Locality 52—Continued

Northeast of Mount Dunfee section, measured 5 miles N. 75° E. of Gold Point, NE¼ sec. 33 and NW¼ sec. 34, T. 6 S., R. 42 E.—Continued

Poleta Formation (incomplete)—Continued

Middle member—Continued — *Feet*

11. Sandstone (75 percent), etc.—Continued very thin bedded; in places, silty and sandy. Sandstone occurs as 1-in.- to 1-ft-thick sets; siltstone occurs in sets of similar size; limestone occurs in layers ½ in. to 1 ft thick. Unit as a whole weathers to form slope with numerous ledges — 115

10. Limestone, medium-dark-gray (*N*5) and minor layers and irregular patches of pale-brown (5*YR* 5/2); weathers medium dark gray (*N*5) and light brown (5*YR* 6/4); aphanitic; crude beds 1–12 in. thick; weathers to form highest of two most prominent gray limestone ledges in middle member of Poleta Formation. Rock has mottled and patchy appearance owing to brown-colored areas which are irregular in shape ½–1 in. across — 6

9. Siltstone (60 percent), sandstone (30 percent), and limestone (10 percent). Siltstone, pale-red (10*R* 6/2), moderate-red (5*R* 5/4), and grayish-orange (10*YR* 7/4); weathers same colors; some medium silt parts, some fine silt and clay parts; abundant silt-sized white mica; thinly laminated; shaly splitting in parts, but generally the coarser grained layers are flaggy splitting. Sandstone, pale-red (10*R* 6/2), moderate-red (5*R* 5/4), and pale-yellowish-brown (10*YR* 6/2); weathers dominantly very dusky red (10*R* 2/2) and dusky yellowish brown (10*YR* 2/2); very fine grained; well indurated; slight calcareous cement in some places, probably siliceous cement in most places; laminated to thin bedded; occurs in 6-in. to 10-ft layers interstratified with the siltstone and limestone. Limestone, medium-gray (*N*5) and grayish-red (5R 4/2); weathers same colors; aphanitic to medium crystalline; thin to very thin bedded; occurs in 1-in. to 2-ft layers. The limestone contains scraps of trilobites, and the sandstone contains molds of brachiopods. Unit as a whole weathers to form slope with minor ledges on the sandstone units — 95

8. Limestone, medium-gray (*N*5); weathers same color; aphanitic to very finely crystalline; crude wavy beds 2–6 in. thick; one 4-in. tabular planar set of low-angle small-scale cross-beds; weathers to form ledge, the lower of two prominent gray ledges in middle member of Poleta Formation — 5

Section transferred on top of unit 7 so that overlying units measured starting 500 ft northeast of underlying units.

7. Siltstone (80 percent), limestone to silty limestone (10 percent), and sandstone (10 percent). Siltstone, grayish-olive (10*Y* 4/2), dark-yellowish-brown (10*YR* 4/2), and moderate-red (5*R* 5/4); weathers same colors;

Locality 52—Continued

Northeast of Mount Dunfee section, measured 5 miles N. 75° E. of Gold Point, NE¼ sec. 33 and NW¼ sec. 34, T. 6 S., R. 42 E.—Continued

Poleta Formation (incomplete)—Continued

Middle member—Continued — *Feet*

7. Siltstone (80 percent), etc.—Continued fine silt to clay; abundant silt-sized white mica; shaly splitting. Limestone to silty limestone, grayish-orange (10*YR* 7/4), dark-yellow-brown (10*YR* 4/2), and medium-light-gray (*N*6); weathers same colors; aphanitic to medium crystalline; thinly laminated to laminated; occur as 1–10-in. sets interstratified with the siltstone. Sandstone; same as that in unit 5; constitutes 40 percent of lowest 10 ft of unit and is rare in rest of unit. Unit contains a medium-gray limestone layer from 60 to 61 ft above base. This limestone resembles that of overlying unit. Unit as a whole weathers to form slope with minor ledge in basal 10 ft. Limestone commonly contains scraps of trilobites. The trilobite *Holmia* (collected and identified by C. A. Nelson, written commun., 1963) occurs near line of section in strata probably equivalent to upper part of unit---- 81
6. Siltstone (90 percent), limestone to silty limestone (5 percent), and sandstone (5 percent). Siltstone; same as that in unit 5. Limestone to silty limestone; same as limestone in unit 5, except some parts are highly silty. Sandstone; same as that in unit 5. The limestone, the silty limestone, and the sandstone occur in 1–4-in. layers interstratified with the siltstone. Scraps of trilobites occur in the limestone. One limestone layer contains conical fossils about ½ in. long (*Hyolithes*?). Unit weathers to form slope-------------- 49
5. Siltstone (60 percent), sandstone (35 percent), and limestone (5 percent). Siltstone, pale-olive (10*Y* 6/2) to grayish-olive (10*Y* 4/2); weathers same colors; fine silt and clay; some silt-sized white mica; shaly splitting. Sandstone, pale-yellowish-brown (10*YR* 6/2) to light-brown (5*YR* 6/4) and medium-light-gray (*N*6); weathers light brown (5*YR* 6/4); very fine grained grading into coarse silt; well indurated; calcareous cement in part, quartzitic in part; evenly laminated; platy to slabby splitting; occurs in 1–10-in. sets interstratified with siltstone. Limestone, very pale orange (10*YR* 3/2), grayish-orange (10*YR* 7/4), and light-olive-gray (5*Y* 5/2); weathers moderate yellowish brown (10*YR* 5/4); aphanitic to medium crystalline; laminated to very thin bedded; occurs as 1–8-in. sets interstratified with the siltstone and sandstone. Amount of sandstone in unit decreases upward. Top contact gradational into overlying unit. Sandstone and limestone contain trilobite scraps and a few molds of brachiopods. Unit as a whole weathers to form ledgy outcrop------------ 31

Locality 52—Continued

Northeast of Mount Dunfee section, measured 5 miles N. 75° E. of Gold Point, NE¼ sec. 33 and NW¼ sec. 34, T. 6 S., R. 42 E.—Continued

Poleta Formation (incomplete)—Continued

Middle member—Continued — *Feet*

4. Siltstone (95 percent) and limestone (5 percent); same as unit 2. Unit weathers to form slope------------------------------ 39
3. Limestone (60 percent) and siltstone (40 percent). Limestone, light-gray (*N*7) to medium-light-gray (*N*6); weathers medium light gray (*N*6) with some dark yellowish orange (10*YR* 6/6); finely to medium crystalline; thinly laminated; two very thin tabular planar sets of small-scale low-angle cross-laminae; platy to slabby splitting. Siltstone; same as in unit 2; occurs in 1–5-in. layers interstratified with 2–10-in. layers of limestone. Limestone in places contains scraps of trilobites. Unit forms minor ledge------- 5
2. Siltstone (95 percent) and limestone (5 percent). Siltstone, pale-yellowish-brown (10*YR* 8/2), light-brown (10*YR* 6/4), and moderate-yellowish-brown (10*YR* 5/4); weathers same colors; fine silt and clay; common silt-sized white mica; papery to shaly splitting. Limestone, moderate-yellowish-brown (10*YR* 8/2); weathers same color and dark yellowish orange (10*YR* 6/6); aphanitic to medium crystalline; occurs as ¼–6-in.-thick layers interstratified with the siltstone; some limestone layers are very thinly bedded. Limestone layers contain abundant scraps of trilobites and a few molds of brachiopods. The trilobite *Nevadella* (USGS colln. 3657–CO, identified by A. R. Palmer, written commun., 1961) collected from lower part of unit about ½ mile south of line of section. Unit as a whole forms gentle slope--------- 157

Total of middle member--------------- 622

Lower member (incomplete):

1. Limestone, medium-gray (*N*5) to medium-dark-gray (*N*4); rare very pale orange (10*YR* 8/2) parts; weathers dominantly medium light gray (*N*6); aphanitic to very finely crystalline; some medium to coarsely crystalline parts; indistinct wavy(?) bedding; beds 1 in. to 2 ft thick; blocky splitting; weathers to form steep ledgy slope. Contains abundant archeocyathids throughout almost all of unit; most of the archeocyathids are ¼–½ in. in diameter and 1–2 in. long; some are as large as 1 in. in diameter and 3 or 4 in. long----- 234+

Total of incomplete lower member------- 234+

Total of incomplete Poleta Formation---- 964+

Base of section at fault. Grayish-red siltstone of Harkless (?) Formation on northwest.

NYE COUNTY, NEVADA

Locality 54

Quartzite Mountain section, measured in six parts extending from the west side of Quartzite Mountain (units 1–4) to 5.3 miles north-northwest of Quartzite Mountain (units 14–18): southern half of sec. 13, T. 5 S., R. 50 E., north-central part sec. 23, west-central part sec. 25, east-central and southeastern part sec. 26, and northwestern part sec. 35, T. 4 S., R. 50 E. (all sections unsurveyed)

[Measured by J. H. Stewart and C. L. Rogers, April 1964]

Wood canyon Formation (incomplete):

Lower member (incomplete): *Feet*

18. Siltstone (75 percent) and quartzite (25 percent). Siltstone, grayish-olive (10*Y* 4/2) and greenish-gray (5*GY* 6/1), micaceous, platy. Quartzite, yellowish-gray (5*Y* 8/1) to pale-yellowish-brown (10*YR* 6/2); weathers dark brownish gray (10*YR* 4/2); fine grained; micaceous in part; laminated 1-in. to 2-ft layers interstratified with siltstone. Unit as a whole weathers to form gentle slope. About 200 ft (estimated) exposed to top of hill; more may crop out to east, but faulting and dip slope make estimate of additional thickness uncertain__ 200±
17. Dolomite to sandy dolomite, grayish-orange-pink (5*YR* 7/2), weathers light brown (5*YR* 6/4); finely crystalline; most parts contain common to abundant fine-grained quartz, locally dolomite grades to dolomitic sandstone; some slightly limy parts; evenly laminated; weather to form minor ledge__ 25
16. Siltstone (75 percent) and quartzite (25 percent). Siltstone; similar to that in unit 15. Quartzite, greenish-gray (5*GY* 6/1), and yellowish-gray (5*Y* 8/1) to pale-yellowish-brown (10*YR* 6/2), mostly fine-grained; some fine- to medium-grained parts; laminated 6-in. to 4-ft layers interstratified with siltstone. Unit contains a few quartzite layers similar to those in unit 14. Unit weathers to form gentle slope____________ 263
15. Siltstone (70 percent) and quartzite (30 percent). Siltstone, light-olive-gray (5*Y* 5/2), and pale-olive (10*Y* 6/2) to grayish-olive (10*Y* 4/2), micaceous, platy. Quartzite, pale-yellowish-brown (10*YR* 6/2), very pale orange (10*YR* 8/2), and yellowish-gray (5*Y* 8/1), fine-grained; some micaceous parts; laminated 6-in. to 2-ft layers interstratified with siltstone. About 10 percent of unit is quartzite similar to that in underlying unit, and unit is transitional sequence from unit 14 to unit 16. Top of unit placed at top of highest prominent quartzite bed that resembles those in unit 14. Some quartzite similar to that in unit

Locality 54—Continued

Quartzite Mountain section, measured in six parts extending from the west side of Quartzite Mountain (units 1–4) to 5.3 miles north-northwest of Quartzite Mountain (units 14–18): southern half of sec. 13, T. 5 S., R. 50 E., north-central part sec. 23, west-central part sec. 25, east-central and southeastern part sec. 26, and northwestern part sec. 35, T. 4 S., R. 50 E. (all sections unsurveyed)—Continued

Wood Canyon Formation (incomplete)—Continued

Lower member (incomplete)—Continued *Feet*

15. Siltstone (70 percent), etc.—Continued
14 occurs in unit 16, but in lesser amount. Unit forms east slope of hogback________ 98

Total of incomplete lower member_____ 586±

Total of incomplete Wood Canyon Formation ______________________ 586±

Stirling Quartzite:

E member:

14. Quartzite, pinkish-gray (5*YR* 8/1) and minor amounts yellowish-gray (5*Y* 8/1) and light-greenish-gray; weathers pale red (10*R* 6/2); fine to medium grained; laminated to thin bedded; many thin to very thin tabular planar sets of cross-strata; weathers to form cliff. A medium-dark-gray (*N*5) phyllitic siltstone occurs from 324 to 328 ft above base of unit. Top 30 ft contains about 20 percent yellowish-gray (5*Y* 8/1) to very pale orange (10*YR* 8/2) fine-grained laminated quartzite that weathers light brown (5*YR* 6/4). Top 30 ft of unit also contains 10 percent grayish-olive (10*Y* 4/2) phyllitic siltstone layers from 6 in. to 2(?) ft thick. Basal contact covered, but located within 15 ft stratigraphically__________________ 400

Offset in section so that overlying units measured 1.3 miles north-northwest of underlying units.

13. Siltstone (65 percent) and quartzite (35 percent). Siltstone, pale-olive (10*Y* 6/2) to grayish-olive (10*Y* 4/2), and greenish-gray (5*GY* 6/1); coarse silt; commonly contains very fine sand in parts; micaceous in places; platy. Quartzite, light-brownish-gray (5*YR* 6/1), grayish-orange-pink (5*YR* 7/2), and pinkish-gray (5*YR* 8/1), fine- to medium-grained, evenly laminated; some low-angle cross-strata; layers from 1 in. to 3 ft thick interstratified with siltstone. Unit as a whole weathers to form steep slope _________________________________ 355
12. Heterogeneous unit of siltstone (60 percent), quartzite and sandstone (35 percent), and limestone (5 percent). Siltstone, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1), grayish-green (5*G* 5/2), and minor amount pale-yellowish-brown (10*YR*

Locality 54—Continued

Quartzite Mountain section, measured in six parts extending from the west side of Quartzite Mountain (units 1–4) to 5.3 miles north-northwest of Quartzite Mountain (units 14–18): southern half of sec. 13, T. 5 S., R. 50 E., north-central part sec. 23, west-central part sec. 25, east-central and southeastern part sec. 26, and northwestern part sec. 35, T. 4 S., R. 50 E. (all sections unsurveyed)—Continued

	Feet
Stirling Quartzite—Continued	
E member—Continued	
12. Heterogeneous unit of siltstone, etc.—Con. 6/2); fine to coarse silt; micaceous in places; platy. Quartzite and sandstone, greenish-gray (5*GY* 6/1), yellowish-gray (5*Y* 8/1), pale-yellowish-brown (10*YR* 6/2), and pinkish-gray (5*YR* 8/1), very fine grained and fine- to medium-grained, commonly limy, evenly laminated to thin-bedded; rare small-scale cross-laminae; 1-in. to 5-ft layers interstratified with siltstone. Limestone, pale-reddish-brown (10*R* 5/4), moderate-red (5*R* 5/4), grayish-red (10*R* 4/2), and yellowish-gray (5*Y* 8/1), finely crystalline, evenly laminated; rare small-scale low-angle cross-laminae; grades rarely to dolomite; contains "pellet" structure (similar to that in unit 10) in a few beds. Unit as a whole weathers to form steep slope. Prominent pinkish-gray (5*YR* 8/1) quartzite occurs rarely from 188 ft above base to top of unit. Carbonate layers are in following positions: 61–69 ft, limestone; 102–106 ft, limestone; 160–165 ft, limestone; 300–320 ft, 50 percent limestone; and 367–395 ft, 30 percent limestone and dolomite	438
Total of E member	1, 193
D member:	
11. Limestone (90 percent?) and siltstone (10 percent?). Limestone, medium-gray (*N*5) and pale-yellowish-brown (10*YR* 6/2); some altered areas that are pale reddish brown (10*R* 5/4) and that weather light brown (10*YR* 5/6); very finely crystalline; commonly has "pellet" structure similar to that of underlying unit; laminated to very thin bedded; rare small-scale cross-laminae. Siltstone, very pale orange (10*YR* 8/2); fine silt; platy; 1–12-in. layers interstratified with limestone. Siltstone is poorly exposed, and the percentage of siltstone is difficult to estimate. Unit weathers to form slope. Unit similar to top part of unit 10, although unit 11 contains more siltstone and weathers into a more gentle slope	80
10. Dolomite and limestone, medium-gray (*N*5) to very light gray (*N*8), and rare very pale orange (10*YR* 8/2), aphanitic to finely crystalline; laminated to very thin bedded; common small-scale low-angle cross-strata; weather to form light-colored cliff. Bottom half of unit predominantly dolomite, top half predominantly limestone; limestone in top half commonly shows "pellet" structure with flakes and rods of limestone set in limestone matrix. Top half of unit shows some distinct bedding when viewed from a distance; lower half is massive appearing from distance. Top 10 ft of unit contains a few thin layers of light-brown (5*YR* 6/4) platy siltstone	203
Total of D member	283
Offset in section so that overlying units measured 1,000 ft northwest of underlying units.	
C member:	
9. Phyllitic siltstone (90 percent) and quartzite (10 percent). Phyllitic siltstone, grayish-purple (5*P* 4/2) to medium-gray (*N*5) and greenish-gray (5*GY* 6/1); fine to coarse silt; micaceous; platy. Quartzite, yellowish-gray (5*Y* 8/1), grayish-purple (5*P* 4/2), and greenish-gray (5*GY* 6/1) to light-greenish-gray (5*GY* 8/1), very fine grained; silty in places; laminated ½–3-in. layers interstratified with the phyllitic siltstone. Two dolomite beds occur in basal part of unit, one from 5 to 7 ft above base and one from 90 to 91 ft above base; dolomite is laminated, very light gray (*N*8), weathers grayish orange (10*YR* 7/4), and is aphanitic to very finely crystalline. Three limestone beds occur near top of unit, one from 728.0 to 728.5 ft, one from 740 to 741 ft, and one from 780 to 783 ft; this limestone is moderate yellowish brown (10*YR* 5/4) to dark yellowish brown (10*YR* 4/2) and weathers same colors; it is aphanitic to finely crystalline and is indistinctly laminated to thin-bedded. Unit from 596 to 826 ft above base is almost entirely greenish-gray phyllitic siltstone and contains no quartzite. Top 9 ft of unit is composed of greenish-gray siltstone, fine-grained silty sandstone, and minor amounts of medium-gray (*N*5) limestone; the limestone, siltstone, and sandstone intergrade	835
Total of C member	835

Locality 54—Continued

Quartzite Mountain section, measured in six parts extending from the west side of Quartzite Mountain (units 1–4) to 5.3 miles north-northwest of Quartzite Mountain (units 14–18): southern half of sec. 13, T. 5 S., R. 50 E., north-central part sec. 23, west-central part sec. 25, east-central and southeastern part sec. 26, and northwestern part sec. 35, T. 4 S., R. 50 E. (all sections unsurveyed)—Continued

Stirling Quartzite—Continued

B member: *Feet*

8. Phyllite and quartzite. Phyllite, medium-gray (*N*5) to grayish-purple (5*P* 4/2); silt-sized particles; micaceous; platy. Quartzite, pinkish-gray (5*YR* 8/1) to yellowish-gray (5*Y* 8/1), fine- to medium-grained; 0.1–3-ft layers; mostly laminated; some cross-strata; constitutes about 10 percent of lower three-fourths of unit and about 50 percent of top one-fourth of unit. Unit essentially transitional from unit 7 to unit 9. Presence of dolomite layers near base of overlying unit suggests that unit 8 should be considered as part of B member ____________ 112

Offset in section so that overlying unit measured 1,000 ft north of underlying units. Possibly as much as 30 ft of section gained or lost in offset.

7. Quartzite (90 percent) and silty sandstone (10 percent). Quartzite, pinkish-gray (5*YR* 8/1), medium-gray (*N*5), and grayish-purple (5*P* 4/2), mostly fine- to medium-grained, laminated to thin-bedded; thin tabular planar sets of cross-strata common. Silty sandstone, light-greenish-gray (5*GY* 8/1) and medium-gray (*N*5) to grayish-purple (5*P* 4/2), very fine grained; laminated ¼–4-in. layers interstratified with quartzite. Unit as a whole weathers to form hogback ____________ 210

Offset in section so that overlying unit measured 700 ft north-northwest of underlying unit. Possibly 50 ft of section gained or lost in offset.

6. Silty sandstone (50 percent), quartzite (40 percent), and siltstone (10 percent). Silty sandstone, pale-purple (5*P* 6/2) and light-greenish-gray (5*GY* 8/1); very fine to fine-grained, scattered medium grains; fair sorting; evenly laminated to very thin bedded. Quartzite, yellowish-gray (5*Y* 8/1) and grayish-purple (5*P* 4/2), fine- to medium-grained; fair sorting; laminated to very thin bedded; some thin sets of cross-strata. Siltstone, light-greenish-gray (5*GY* 8/1) and medium-gray (*N*5); coarse silt; very fine sand common; ½–2-in. layers interstratified with silty sandstone and quartzite. Quartzite is in layers from an inch to several feet thick. It increases in amount upward, and in top 100 ft of unit constitutes about 80 percent of the strata. All lithologic types are gradational. Contact with overlying unit gradational. Unit as a whole weathers to form slope with cliffs in upper part. Unit

Locality 54—Continued

Quartzite Mountain section, measured in six parts extending from the west side of Quartzite Mountain (units 1–4) to 5.3 miles north-northwest of Quartzite Mountain (units 14–18): southern half of sec. 13, T. 5 S., R. 50 E., north-central part sec. 23, west-central part sec. 25, east-central and southeastern part sec. 26, and northwestern part sec. 35, T. 4 S., R. 50 E. (all sections unsurveyed)—Continued

Stirling Quartzite—Continued

B member—Continued *Feet*

6. Silty sandstone (50 percent), etc.—Con. from 215 to 335 ft above base is covered, but outcrops about 1,000 ft north indicate that the lithology of this interval is the same as rest of unit. Unit as a whole is well bedded and notable for color alternations from purple to green. A few ripple marks noted in top 100 ft of unit. Unit faulted at top contact, and block to north downdropped about 30–40 ft. Unit 7 measured in the downdropped block. Some beds may have been deleted or duplicated across the fault, but probably less than 50 ft of beds were affected ____________ 745±

5. Quartzite, pinkish-gray (5*YR* 8/1), yellowish-gray (5*Y* 8/1), and grayish-purple (5*P* 4/2), very fine grained and fine- to medium-grained, laminated to thin-bedded; weathers to form gentle slope. Poorly exposed. Unit is transitional between unit 4 and unit 6 ____________ 65

Total of B member ____________ 1, 132

Offset in section so that overlying units measured 3.7 miles north-northwest of underlying units.

A member (incomplete):

4. Quartzite, pinkish-gray (5*YR* 8/1) and yellowish-gray (5*Y* 8/1); weathers same colors; mostly fine to medium grained; some very coarse to coarse-grained parts; some conglomeratic layers in lower 20 ft containing quartz pebbles as large as 0.3 in. in diameter; thin bedded; a few tabular planar sets (½–1 ft thick) of cross-strata; weathers to form cliff. Lower contact at color change from mostly purplish rocks below to mostly pinkish-gray rocks above. This contact is arbitrary and probably of little local or regional significance. Elsewhere in area, pinkish-gray intervals appear in unit 1 as well as in this unit. Top of unit placed at base of lowest purplish silty quartzite bed that marks transition into more silty unit above. Top of unit marks change from cliff-forming units below to saddle or gentle-slope-forming unit above ____________ 75

3. Quartzite, medium-dark-gray (*N*4) with purplish cast; some irregular areas of yellowish gray (5*Y* 8/1); fine to coarse grained; thin bedded; tabular planar sets (mostly ½–1 ft thick) of cross-strata; weathers to form

Locality 54—Continued

Quartzite Mountain section, measured in six parts extending from the west side of Quartzite Mountain (units 1–4) to 5.3 miles north-northwest of Quartzite Mountain (units 14–18): southern half of sec. 13, T. 5 S., R. 50 E., north-central part sec. 23, west-central part sec. 25, east-central and southeastern part sec. 26, and northwestern part sec. 35, T. 4 S., R. 50 E. (all sections unsurveyed)—Continued

Stirling Quartzite—Continued

A member (incomplete)—Continued *Feet*

3. Quartzite, medium-dark-gray, etc.—Con. cliffs and cobble-covered slopes. Some conglomeratic layers (2 percent? of unit) occur in unit, mostly in upper half, and contain pebbles (as large as half an inch in diameter) of quartz and a few of quartzite and of red chert. Some greenish-gray phyllitic silty sandstone layers along bedding planes — 300
2. Phyllite (80 percent) and quartzite (20 percent). Phyllite, medium-light-gray (*N*6) olive-gray (5*Y* 4/1), highly micaceous (probably could be called a schist). Quartzite, grayish-purple (5*P* 4/2), very fine grained, micaceous; ½–2-in. layers(?) in phyllite; mostly in lower 15 ft of unit, where it constitutes nearly 50 percent of rock. Unit forms poorly exposed slope and produces noticeable break in sequence of quartzite — 35
1. Quartzite, grayish-purple (5*P* 4/2) to medium-gray (*N*5); weathers similar colors; mostly fine to coarse grained, some conglomeratic parts containing granules and pebbles of quartz as large as 0.4 in. in diameter; fair to poor sorting; composed of quartz and 5–10 percent kaolinized(?) feldspar; thin to thick bedded; some 6-in. to 4-ft tabular planar sets of cross-strata; weathers to form cliffs and rubble-covered slopes. Bedding planes commonly marked by laminae of greenish-gray (5*GY* 6/1) micaceous siltstone (or phyllite) — 1,430

Total of incomplete A member — 1,840

Total of incomplete Stirling Quartzite — 5,283

Base of section; base of lowest outcrop that is definitely in place. Fifty to a hundred feet of strata may be below this horizon, but these strata are mostly covered by talus. Major fault is about 100 ft downhill.

Locality 55

Belted Range section, measured on west side of Belted Range, 2½ miles west of Cliff Spring and about 5½ miles southwest of Belted Peak, northern part secs. 20 and 21, both unsurveyed, T 5 S., R. 52 E.

[Measured by J. H. Stewart and C. L. Rogers, April 1964]

Area cut by many faults with stratigraphic displacements of 10–40 ft common; however, these faults cannot be

Locality 55—Continued

Belted Range section, measured on west side of Belted Range, 2½ miles west of Cliff Spring and about 5½ miles southwest of Belted Peak, northern part secs. 20 and 21, both unsurveyed, T. 5 S., R. 52 E.—Continued

located, except rarely, along the line of section, for outcrops are poor and many of the units have similar lithologic characteristics. The thicknesses of the units are therefore probably somewhat in error. Rhyolite dikes also cut the section in places, further indicating the possible inaccuracy of the thicknesses.

Zabriskie Quartzite: *Feet*

12. Quartzite, yellowish-gray (5*Y* 8/1) and pale-yellowish-brown (10*YR* 6/2); weathers same colors and pale red (5*R* 6/2); fine grained; some medium grains; no noticeable stratification; weathers to form prominent ridge. Thickness approximate because of faulting and difficulty of exactly locating top contact, which is covered by talus. One hundred feet, however, must be very close to actual thickness. C. L. Rogers estimated a thickness of 100 ft farther north on outcrop — 100±
11. Quartzite and siltstone, poorly exposed. Quartzite, very pale orange (10*YR* 8/2), fine-grained and fine- to medium-grained; occurs in 0.5–1-ft layers. Siltstone, very pale orange (10*YR* 8/2) to grayish-orange (10*YR* 7/4); fine to coarse silt; some mica. Siltstone may be dominant lithologic type in top half of unit. Unit may be transitional sequence from Wood Canyon to Zabriskie, and it is included in Zabriskie. The outcrops are so poor, however, that the exact character of the unit cannot be determined. Unit weathers to form rubble-covered slope — 53

Total of Zabriskie Quartzite — 150±

Wood Canyon Formation:

Upper member:

10. Siltstone and quartzite; similar to unit 8; poorly exposed. Unit appears to be dominantly quartzite in lower half and dominantly siltstone in upper half. Some brown-weathering dolomite float and a few outcrops of 1-ft beds of dolomite occur in lower 150± ft of unit — 360
9. Carbonate rock (60 percent), quartzite (30 percent), and siltstone (10 percent). Carbonate rock, pale-yellowish-brown (10*YR* 6/2) and grayish-red (10*R* 4/2); weathers dominantly dark yellowish brown (10*YR* 4/2); very finely crystalline or oolitic; some parts containing disseminated fine to medium quartz; mostly laminated to thin bedded; some small-scale low-angle cross-strata. Both limestone and dolomite occur, limestone as two 3-ft layers in lower 15 ft of unit and dolomite in the rest of the unit. Quartzite and siltstone; same as in unit 8. Unit forms brown slope with a few minor ledges — 100

Locality 55—Continued

Belted Range section, measured on west side of Belted Range, 2½ miles west of Cliff Spring and about 5½ miles southwest of Belted Peak, northern part secs. 20 and 21, both unsurveyed, T. 5 S., R. 52 E.—Continued

Wood Canyon Formation—Continued

Upper member—Continued — *Feet*

8. Siltstone and quartzite. Siltstone, grayish-olive (10*Y* 4/2) and dusky-yellow (5*Y* 6/4); coarse silt; micaceous; platy splitting in part. Quartzite, pale-yellowish-brown (10*YR* 6/2) and yellowish-gray (5*Y* 8/1), very fine to fine-grained; micaceous in parts; laminated. Quartzite is rare in lower third of unit and increases in amount upwards to perhaps 60 percent of upper third. A 4-ft layer of fine- to medium-grained quartzite, similar to that in unit 7, occurs from 115 to 119 ft, and several layers of this same type of quartzite occur from 208 to 236 ft above base of unit. Trilobite fragments occur in quartzite float at 676 ft above base of unit. Unit forms saddle in lower part and slope in upper part — 853

Total of upper member — 1,313

Offset in section so that overlying units measured starting 500 ft to south.

Middle member:

7. Quartzite and minor siltstone. Quartzite, pale-red (5*R* 6/2) to grayish-red (5*R* 4/2), and yellowish-gray 5*Y* 8/1); yellowish gray becomes more prominent in unit upward and constitutes the dominant color in top one-third of unit; quartzite grades from very fine grained silty quartzite to conglomeratic coarse-grained quartzite; conglomerate occurs in basal 10–20 ft of unit and contains granules and small pebbles (as large as ½ in.) of quartz and quartzite. Quartzite becomes generally finer grained upward, although some very fine-grained quartzite occurs in lower part and some coarse-grained quartzite occurs in upper part. Quartzite is irregularly bedded in beds from 1–6-in. thick and contains thin trough sets of low-angle cross-strata. Siltstone, grayish-purple (5*P* 4/2) and grayish-olive (10*Y* 4/2); fine to coarse silt; some mica; platy splitting. Siltstone occurs as thin to thick layers interstratified with quartzite and may constitute 10–30 percent of unit. Exact amount of siltstone, however, is difficult to estimate owing to poor exposures. Unit from 40 to 140 ft forms a saddle and contains common micaceous very fine grained sandstone and quartzite, some of which is grayish red and rare parts of which are grayish olive. Unit from 709 to 874 ft forms a saddle and contains common purplish siltstone in lower part and yellowish-gray and pale-yellowish-

Locality 55—Continued

Belted Range section, measured on west side of Belted Range, 2½ miles west of Cliff Spring and about 5½ miles southwest of Belted Peak, northern part secs. 20 and 21, both unsurveyed, T. 5 S., R. 52 E.—Continued

Wood Canyon Formation—Continued

Middle member—Continued — *Feet*

7. Quartzite and minor siltstone, etc.—Con. brown very fine grained micaceous sandstone in upper part; this interval contains dusky yellow siltstone in upper part. Top 130 ft of unit contains common (40 percent?) grayish-olive siltstone, similar to that in overlying unit. Unit contains several rhyolite dikes; the thickness of these dikes is not included in the thickness of the unit — 1,117

Total of middle member — 1,117

Lower member:

6. Quartzite and siltstone, poorly exposed; similar to unit 4 — 18
5. Sandy dolomite, pale-yellowish-brown (10*YR* 6/2) and grayish-red (5*R* 4/2); weathers dark yellowish brown (10*YR* 4/2); very finely crystalline dolomite containing 10–30 percent very fine quartz grains and in a few layers containing scattered fine to coarse quartz grains; laminated to very thin bedded; weathers to form brown slope — 23
4. Quartzite and siltstone, poorly exposed; similar to unit 2. Mostly quartzite float; some of the quartzite is yellowish gray (5*Y* 8/1), and some is pale red (5*R* 6/2). Very little siltstone occurs in the float, but quartzite float probably masks siltstone. A 3-ft brown-weathering dolomite occurs from 215 to 218 ft above base of unit. Some invertebrate tracks and trails in siltstone — 603
3. Dolomite, medium-gray (*N*5) and moderate-yellowish-brown (10*YR* 5/4); weathers moderate yellowish brown (10*YR* 5/4) and dark yellowish brown (10*YR* 4/2); very finely crystalline; evenly laminated to very thin bedded; weathers to form brownish gentle slope — 33
2. Mostly covered, good outcrops from 263 to 297 ft above base and poor outcrops in top 170 ft; outcrops are of siltstone and minor quartzite. Siltstone, grayish-olive (10*Y* 4/2) and pale-red (5*R* 6/2) to grayish-red (5*R* 4/2); fine to coarse silt; micaceous in part; commonly platy splitting. Quartzite, yellowish-gray (5Y 8/1), very fine to fine-grained, well-sorted, evenly laminated; probably occurs in layers 0.1–1 ft thick. Unit forms flat area west of main exposures of Wood Canyon Formation — 643

Total of lower member — 1,320

Total of Wood Canyon Formation — 3,750

Locality 55—Continued

Belted Range section, measured on west side of Belted Range, 2½ miles west of Cliff Spring and about 5½ miles southwest of Belted Peak, northern part secs. 20 and 21, both unsurveyed, T. 5 S., R. 52 E.—Continued

	Feet
Stirling Quartzite:	
1. Quartzite, pale-red (5*R* 6/2) and yellowish-gray (5*Y* 8/1), medium- to coarse-grained; subangular to subrounded grains; indistinct very thin beds to laminae; possibly some low-angle cross-strata; forms rubbly outcrop in low hills. Several hundred feet exposed, but not measured	Unmeasured

Locality 58

Lees Camp section, measured on west side of isolated hills about 3–4 miles north of Lees Camp, measured starting about 3.5 miles northwest of NW cor. T. 16 S., R. 48 E., and ending about 4.5 miles northwest of same corner

[Measured by J. H. Stewart, April 1965]

	Feet
Stirling Quartzite (incomplete):	
D. member:	
11. Dolomite, light-olive-gray (5*Y* 6/1); grayish orange (10*YR* 7/4) in lower 15 ft; weathers grayish orange (10*YR* 7/4) in lower 15 ft and yellowish gray (5*Y* 8/1) in rest of unit; aphanitic to very finely crystalline; laminated; weathers to form ridge. About 100 ft of unit is exposed. Top not exposed. Alluvium to west	Unmeasured
C. member:	
10. Quartzite, yellowish-gray (5*Y* 8/1) and very pale orange (10*YR* 8/2); weathers dark-yellowish brown (10*YR* 4/2); fine to medium grained; slightly limy and dolomitic; thin bedded; weathers to form ledge	15±
9. Siltstone (85 percent) and quartzite (15 percent). Siltstone, light-greenish-gray (5*GY* 8/1), greenish-gray (5*GY* 6/1), medium-gray (*N*5), light-olive-gray (5*Y* 6/1), and very pale orange (10*YR* 8/2); fine to coarse silt; micaceous; phyllitic; platy splitting. Quartzite, greenish-gray (5*GY* 6/1), yellowish-gray (5*GY* 8/1), and very pale orange (10*YR* 8/2), very fine grained; grades into sandy coarse-grained siltstone; laminated; occurs in 1-in. to 2-ft layers. Unit weathers to form rolling hills. A few 6-in. layers of dolomite occur in lower half and in top 60 ft of unit. Thickness of unit quite uncertain because of minor folding and faulting. The section looks about 1,000 ft thick, but this is difficult to prove or disprove. Some strata could be duplicated in section	1,000(?)
8. Siltstone (55 percent), quartzite (37 percent), and dolomite (8 percent). Siltstone, light-greenish-gray (5*GY* 8/1) to greenish gray (5*GY* 6/1); medium silt; micaceous;	

Locality 58—Continued

Lees Camp section, measured on west side of isolated hills about 3–4 miles north of Lees Camp, measured starting about 3.5 miles northwest of NW cor. T. 16 S., R. 48 E., and ending about 4.5 miles northwest of same corner—Continued

	Feet
Stirling Quartzite (incomplete)—Continued	
C member—Continued	
8. Siltstone (55 percent), etc.—Continued platy splitting. Quartzite, yellowish-gray (5*GY* 8/1), light-olive-gray (5*Y* 6/1), and rare pale-red (5*R* 6/2); grades from very fine grained to medium-grained; laminated to very thin bedded; occurs in 6-in. to 3-ft layers interstratified with siltstone. Dolomite, light-olive-gray (5*Y* 6/1), pale-yellowish-brown (10*YR* 6/2), and medium-gray (*N*5); weathers moderate yellowish brown (10*YR* 5/4); aphanitic to very finely crystalline; laminated to thin bedded; occurs mostly in 6-in. to 4-ft layers. Unit weathers to form rolling hills. Unit crosses some minor faults, and exact thickness of unit difficult to determine; probably within 50 ft of being correct. Sequence in lower 11 ft of unit is as follows: 0–4 ft, siltstone; 4–8 ft, dolomite with minor siltstone; 8–9 ft, coarse-grained brown-weathering dolomitic sandstone; 9–11 ft, dolomite and sandy dolomite	508±
Total of C member	1,523±
B member:	
7. Quartzite (90 percent) and siltstone (10 percent). Quartzite, medium-gray (*N*5) with purple cast and rare light-greenish-gray (5*GY* 8/1), very fine to fine-grained; some fine- to medium-grained parts; laminated to very thin bedded; irregular stratification; some waviness and possibly some very low angle cross-strata. Siltstone, medium-gray (*N*5) with purple cast, and minor light-greenish-gray (5*GY* 8/1); medium to coarse silt; grades into silty very fine grained quartzite, platy splitting; occurs in ⅛–3-in. layers interstratified with quartzite. Unit weathers to form slope containing several ledgy parts. Top 75 ft of unit forms cliff and probably contains more fine- to medium-grained quartzite than rest of unit. Several small faults cut unit, but thickness of unit is probably within 50 ft of being correct	430±
6. Quartzite (60 percent), coarse siltstone (30 percent), and dolomite to silty dolomite (10 percent). Quartzite and coarse siltstone; similar to that in underlying unit. Dolomite to silty dolomite, pinkish-gray (5*YR* 8/1) to pale-red (5*R* 6/2) and grayish-orange-pink (5*YR* 7/2); weather light brown (5*YR* 6/4); finely crystalline; commonly silty (coarse silt); lami-	

Locality 58—Continued

Lees Camp section, measured on west side of isolated hills about 3–4 miles north of Lees Camp, measured starting about 3.5 miles northwest of NW cor. T. 16 S., R. 48 E., and ending about 4.5 miles northwest of same corner—Continued

Stirling Quartzite (incomplete)—Continued

B member—Continued — *Feet*

6. Quartzite (60 percent), etc.—Continued nated to thin bedded; occur in 1–8-in. layers interstratified with quartzite and siltstone. Dolomite to silty dolomite constitute 20 percent of unit from 0 to 18 ft above base, are absent from 18 to 39 ft above base, and constitute 15 percent of unit from 39 to 75 ft above base. Unit weathers to form slope; forms fairly prominent brown band on outcrop — 75
5. Quartzite (90 percent) and coarse siltstone (10 percent). Quartzite, medium-gray (*N*5) with purple cast, and rare very pale orange (10*YR* 8/2), very fine to fine-grained; some fine- to medium-grained parts; laminated to very thin bedded; some waviness to stratification. Coarse siltstone, medium-gray (*N*5) with purple cast, and rare light-greenish-gray (5*GY* 8/1), micaceous; occurs as ⅛–3-inch layers. Unit weathers to form slope. Brown-weathering sandy dolomite, silty dolomite, or dolomitic siltstone layers occur from 45 to 46 ft, from 80 to 83 ft, and from 110 to 111 ft — 118

Total of B member — 623±

Section transferred on top of unit 4 so that unit 5 measured about 200 ft to south of unit 4.

A member (incomplete):

4. Quartzite, medium-gray (*N*5) with purple cast, and yellowish-gray (5*GY* 8/1); mostly medium gray in lower 130 ft and mostly yellowish gray in rest of unit; fine to medium grained and medium to coarse grained; rare conglomeratic parts containing granules of quartz and quartzite; thin bedded; minor tabular planar sets of small-scale cross-strata; weathers to form cliff. Unit is finer grained and thinner bedded in top 50 ft — 292
3. Phyllite (50 percent) and quartzite (50 percent). Phyllite, medium-gray (*N*5) with purple cast; well-defined schistosity. Quartzite, grayish-red-purple (5*RP* 4/2), fine- to medium-grained and medium- to coarse-grained; occurs in very thin to thin beds interstratified with phyllite. Unit weathers to form slope — 20
2. Carbonate rock. Dolomite, 0–12 ft; covered, 12–24 ft; limestone, 24–43 ft; dolomite, 43–53 ft. Dolomite, moderate-red (5*R* 5/4); weathers mostly moderate brown (10*YR* 4/4) to pale brown (5*YR* 5/2); finely crystalline (the crystals weather out

Locality 58—Continued

Lees Camp section, measured on west side of isolated hills about 3–4 miles north of Lees Camp, measured starting about 3.5 miles northwest of NW cor. T. 16 S., R. 48 E., and ending about 4.5 miles northwest of same corner—Continued

Stirling Quartzite (incomplete)—Continued

A member (incomplete)—Continued — *Feet*

2. Carbonate rock. Dolomite, etc.—Continued and resemble oolites in places); crudely laminated. Limestone, moderate-red (5*YR* 5/4) and very pale orange (10*YR* 8/2), finely crystalline, laminated. Unit weathers to form light-colored ledge. Unit same as unit 22 in Indian Pass section (locality 10) — 53±
1. Phyllite (90 percent) and quartzite (10 percent). Phyllite, medium-gray (*N*5); well-defined schistosity. Quartzite, grayish-red-purple (5*RP* 4/2), medium- to coarse-grained; occurs in 4–8 in. beds. Unit about 50 ft thick and underlain by grayish-red-purple quartzite — (Unmeasured)

Total of incomplete A member — 365

Total of incomplete Stirling Quartzite — 2, 511

Locality 64

Wood Canyon section, measured along Wood Canyon, southeasternmost part sec. 7 and southern part sec. 8, T. 18 S., R. 54 E.

[Measured by J. H. Stewart, September 1963]

Wood Canyon Formation:

Lower member: — *Feet*

18. Siltstone, olive-gray (5*Y* 4/1); weathers same color; fine to medium silt; abundant very fine grained white mica; irregularly platy; weathers to form slope. Unit at least 50 ft thick, but only basal few feet examined — Unmeasured

Stirling Quartzite:

E member:

NOTE.—Units 11–17 measured on south side of Wood Canyon.

17. Quartzite and siltstone. Quartzite, yellowish-gray (5*Y* 8/1); weathers same color; very fine grained in some parts, medium to coarse grained in other parts; very rarely contains granules of white and pink quartz; evenly laminated; laminae are commonly very gently inclined cross-strata. Siltstone, pale-yellowish-brown (10*YR* 6/2) and rare grayish-red (5*R* 4/2); weathers same colors; coarse silt; abundant white mica; platy. Siltstone is very poorly exposed, but seems to occur entirely in lower half of unit and to decrease in amount upward. Perhaps a third of lower half of unit is siltstone. Unit as a whole weathers to form slope with white quartzite ledge in upper part — 63
16. Quartzite, pinkish-gray (5*YR* 8/1) to white (*N*9); weathers same colors; fine to coarse grained (grain size variable) and rarely con-

Locality 64—Continued

Wood Canyon section, measured along Wood Canyon, southeasternmost part sec. 7 and southern part sec. 8, T. 18 S., R. 54 E.—Con.

	Feet
Stirling Quartzite—Continued	
E member—Continued	
16. Quartzite, pinkish-gray, etc.—Continued glomeratic with granules and pebbles of white and of pink quartz (and quartzite?) as large as 1½ in.; laminated; some gently dipping medium- to large(?)-scale cross-laminae; weathers to form prominent white ledge	45
15. Quartzite and sandstone (70 percent) and siltstone (30 percent). Quartzite and sandstone; grade from yellowish-gray (5*Y* 8/1) fine-grained quartzite to moderate-yellowish-brown (10*YR* 5/4) micaceous very fine grained (commonly silty) sandstone (sandstone in subordinate amount); laminated; some laminae are gently inclined medium-scale cross-laminae. Siltstone, moderate-yellowish-brown (10*YR* 5/4) to dusky-yellow (5*Y* 6/4); weathers same colors; coarse silt; abundant white mica; laminated; platy. Unit as a whole weathers to form conspicuous reentrant near top of Stirling Quartzite	30
14. Quartzite and rare conglomerate, pinkish-gray (5*YR* 8/1); about one-half of strata in top 100 ft of unit are yellowish gray (5*Y* 8/1) and light greenish gray (5*GY* 8/1); weather same colors; fine to medium grained, but some contain 1–6 in. layers that are medium to very coarse grained; conglomerate is common from 350 to 590 ft above base of unit and increases in abundance upward in this interval; it contains granules and pebbles of white quartz and quartzite (75 percent) and jasper (25 percent) that are as large as ½ in., but near the top of the interval the conglomerate is coarser, and the pebbles are as large as 1.2 in. Quartzite is composed of discontinuous laminae, some sets of which occur in shallow scours; it contains some low-angle cross-laminae. About 25 percent of unit is composed of 0.3–2 ft tabular planar and trough sets of small- to medium-scale cross-laminae. Unit weathers to form cliff	694
13. Quartzite (98 percent) and siltstone (2 percent). Quartzite, yellowish-gray (5*Y* 8/1) and pinkish-gray (5*YR* 8/1); has many thin layers that are dark yellowish brown (10*YR* 4/2) and light greenish gray (5*GY* 8/1) and a few layers that are grayish red (5*R* 4/2); weathers same colors; fine to medium grained; evenly laminated; some slightly wavy laminae; thin tabular planar sets of small-scale cross-laminae are common. Siltstone, grayish-red-purple (5*RP* 4/2); weathers same color; coarse silt; abundant white mica; evenly laminated; platy. Unit as a whole weathers to form cliff. Siltstone occurs as thin films between quartzite sets and as 6-in. to 1-ft layers.	

Locality 64—Continued

Wood Canyon section, measured along Wood Canyon, southeasternmost part sec. 7 and southern part sec. 8, T. 18 S., R. 54 E.—Con.

	Feet
Stirling Quartzite—Continued	
E member—Continued	
13. Quartzite (98 percent), etc.—Continued Top 5 ft of unit is locally almost entirely siltstone	303
Total of E member	1,135
D member:	
12. Sandstone to limy sandstone (60 percent) and siltstone (40 percent). Sandstone to limy sandstone, pinkish-gray (5*YR* 8/1); weather same color and dark yellowish brown (10*YR* 4/2); fine to medium grained; laminated; laminae slightly wavy. Some layers of sandstone commonly are distinctly limy and weather dark yellowish brown. A few thin layers of sandstone are dark yellowish brown and weather the same color. Siltstone; same as in unit below; in sets 1–8 in. thick. Unit weathers to form reentrant and is commonly covered along outcrop. Unit grades upward into overlying unit	22
11. Quartzite (90 percent) and siltstone (10 percent). Quartzite, yellowish-gray (5*Y* 8/1) and pale-red (10*R* 6/2); weathers same colors; fine to medium grained; laminated; a few thin tabular planar sets of small-scale cross-laminae. Siltstone, pale-red (5*R* 6/2), weathers grayish red (5*R* 4/2); coarse silt; some coarse-grained white mica; laminated 1–10-in. sets interstratified with the quartzite. Unit weathers to form white ledge	17
Total of D member	39
C member:	
NOTE.—Units 9 and 10 measured about 700 ft north of Wood Canyon.	
10. Siltstone and quartzite. Siltstone, grayish-red (5*R* 4/2) and rare light-brownish-gray (5*YR* 6/1); weathers same colors and blackish red (5*R* 2/2); coarse silt; common to abundant medium-grained white mica; evenly laminated; platy. Quartzite, grayish-red (5*R* 4/2), pale-red (5*R* 6/2), and minor amounts light-greenish-gray (5*GY* 8/1) and light-gray (*N*7); weathers same colors; mostly very fine to fine grained; some fine- to medium-grained layers in upper fourth; evenly laminated; rare low-angle small-scale cross-strata near top of unit; in layers 1 in. to 3 ft thick interstratified with siltstone layers of comparable thickness. Amount of quartzite increases upward in unit from about 25 percent in lower fourth to about 75 percent in upper fourth. Unit gradational into overlying unit. Upper contact of unit placed at base of promi-	

Locality 64—Continued

Wood Canyon section, measured along Wood Canyon, southeasternmost part sec. 7 and southern part sec. 8, T. 18 S., R. 54 E.—Con.

Stirling Quartzite—Continued

C member—Continued

Feet

10. Siltstone and quartzite, etc.—Continued nent white quartzite layer (unit 11). Siltstone is commonly ripple marked; crests of ripples are generally parallel, but some crests are irregular. Quartzite locally contains flat pieces siltstone as large as an inch in diameter. Unit weathers to form steep slope. Units 9 and 10 form a saddle in middle of Stirling Quartzite ---------- 377
9. Siltstone; grayish red (5*R* 4/2) from 0 to 100 ft; dusky yellow (5*Y* 6/4) and grayish orange (10*YR* 7/4) and has minor amount greenish gray (5*GY* 6/1) from 100 to 215 ft; greenish gray from 215 to 231 ft; weathers same colors; coarse silt grading to very fine sand (about 25 percent of unit may be silty very fine grained sandstone), grain size near boundary of silt and sand; common to abundant very fine grained white mica; laminated; platy; weathers to form gentle slope. Much of unit is poorly exposed. Worm burrows(?) noted on some bedding planes ---------- 231

Total of C member ---------- 608

B member:

Note.—Units 7 and 8 measured on south side of Wood Canyon.

8. Quartzite and minor amount of siltstone in lower 100 ft. Quartzite, grayish-red (5*R* 4/2), grayish-purple (5*P* 4/2), light-greenish-gray (5*GY* 8/1), greenish-gray (5*GY* 6/1), yellowish-gray (5*Y* 8/1), and pinkish-gray (5*YR* 8/1); weathers dominantly grayish red (5*R* 4/2) and yellowish gray (5*Y* 8/1); colors occur in thin beds giving unit banded appearance; grain size varies from very fine to very coarse; rock is most commonly fine grained; very coarse and coarse-grained parts occur in thin units interstratified with fine-grained rock in upper half of unit; quartzite is evenly laminated; has a few very thin beds as well as 1–6-in. tabular planar sets of small-scale cross-laminae; parallel and cusp(?) ripple marks are common. Siltstone, grayish-red (5*R* 4/2) greenish-gray (5*GY* 6/1); weathers same colors; coarse silt grading to very fine sand; commonly contains coarse-grained white mica; laminated 1-in. to 1-ft layers interstratified with quartzite; constitutes about 20 percent of basal 100 ft of unit. Unit weathers to form cliff characterized by even banding ---------- 322

Total of B member ---------- 322

Note.—Top 50 ft of unit 7 may also belong in B member.

Locality 64—Continued

Wood Canyon section, measured along Wood Canyon, southeasternmost part sec. 7 and southern part sec. 8, T. 18 S., R. 54 E.—Con.

Stirling Quartzite—Continued

A member: *Feet*

7. Quartzitic conglomerate to quartzite, pinkish-gray (5*YR* 8/1), yellowish-gray (5*Y* 8/1), and minor amount light-greenish-gray (5*GY* 8/1); weather dominantly very pale orange (10*YR* 8/2); grade from pebble conglomerate to fine-grained quartzite, grain size generally decreasing upward. The fine quartzite is found only in top 50 ft; pebble conglomerate occurs in several layers in bottom 20 ft—pebbles are quartz, and the largest noted was 1.1 in. in maximum diameter. Much of rest of unit is conglomerate or conglomeratic and is very coarse grained except for top 50 ft. Unit is composed of 0.3–2-ft tabular planar sets of cross-strata and about equal amounts of laminated to thin-bedded parts. Unit weathers to form light-colored cliff. Top 50 ft of unit includes minor amounts (5 percent) of pale-olive (10*Y* 6/2) and dusky-yellow (5*Y* 6/4) coarse siltstone interstratified with the quartzite. Some of quartzite is grayish red (5*R* 6/2) in top 20 ft. Top 50 ft of unit is essentially transitional into overlying unit. Contact with overlying unit arbitrary and placed at top of highest prominent yellowish-gray quartzite ---------- 207

Note.—Unit 6 measured on north side of canyon.

6. Quartzite to conglomeratic quartzite and small amount of siltstone. Quartzite to conglomeratic quartzite, grayish-purple (5*P* 4/2) and grayish-red-purple (5*RP* 4/2); weathers very dusky red purple (5*RP* 2/2); has medium- to coarse-grained parts that grade to coarse-grained to very coarse grained parts with scattered granules and small pebbles (as large as ½ in.) of quartz and sparse red jasper (chert); fair to poor sorting; composed of tabular planar and shallow trough sets of small- to medium-scale cross-strata 6 in. to 5 ft thick; about 50 percent of quartzite is laminated to thin bedded; bedding slightly wavy and irregular; a few scour surfaces 10 ft across and 6 in. to 2 ft deep; much of stratification difficult to see. Siltstone, grayish-purple (5*P* 4/2); weathers very dusky purple (5*P* 2/2); coarse silt grading to very fine sand; abundant coarse-grained white mica; evenly laminated; platy cleavage at angle to bedding; rock is probably more accurately called a phyllite. Siltstone occurs from 0 to 11 ft and from 40 to 50 ft above base of unit, commonly as 6-in. to 2-ft-thick layers from 120 to 140 ft above base of unit, and very rarely as layers less than 6 in. thick in rest of unit. Unit as a whole weathers to form steep ledgy slope and cliffs. Units from 97 to 120 ft contains mostly pinkish-gray (5*YR* 8/1) quartzite that forms light band on outcrop ---------- 388

Locality 64—Continued

Wood Canyon section, measured along Wood Canyon, southeasternmost part sec. 7 and southern part sec. 8, T. 18 S., R. 54 E.—Con.

Stirling Quartzite—Continued

A member—Continued — Feet

NOTE.—Units 1–5 measured on south side of Wood Canyon.

5. Quartzite to quartzitic conglomerate, and rare siltstone to silty sandstone. Quartzite to quartzitic conglomerate; same as in underlying unit except about one-third is grayish red purple (5*RP* 4/2) and weather same color. Siltstone to silty sandstone, grayish-red-purple (5*RP* 4/2) to grayish-purple (5*P* 4/2); weather same colors; coarse silt to very fine sand; abundant white mica; evenly laminated sets 1 in. to 2 ft thick; constitute about 25 percent of unit from 71 to 115 ft above base and also found in two 6-in. layers in top 5 ft; absent from rest of unit. Unit as a whole weathers to form cliff. Forms purplish cap to unit 4. Top half of unit is lighter colored and resembles unit 4 — 162
4. Quartzite to quartzitic conglomerate, pale-red (10*R* 6/2); commonly light greenish gray (5*GY* 8/1) and greenish gray (5*GY* 6/1) along bedding planes; weather pale red (10*R* 6/2); grade from fine-grained quartzite to granule conglomerate. Probably about 25 percent of unit is conglomerate; over half of unit is either conglomeratic or conglomerate; granules and pebbles are quartz and sparse (5 percent) red jasper (chert); sorting is generally poor to fair. Indistinct 6-in. to 3-ft sets of small- to medium-scale cross strata are abundant; most of the sets are probably tabular planar; possibly half of unit is composed of irregularly laminated to thin-bedded strata. Unit weathers to form light-colored cliff. Basal 70 ft of unit is entirely fine-grained quartzite. Conglomerate is most abundant from 225 to 400 ft above base of unit. Top 50 ft of unit is generally medium to coarse grained, although it contains some conglomeratic parts. Largest pebble is 1½ in. in maximum diameter — 450
3. Hematite-stained sandstone, dusky-red (5*R* 3/4) to dark-reddish-brown (10*R* 3/4); weathers same colors; fine to medium grained; fair sorting; composed of small-scale cross-laminae in irregular trough sets 1–3 in. thick, probably ripple cross-strata; some wavy irregular laminae; weathers to form distinctive red ledge — 4
2. Quartzite, pale-red (10*R* 6/2) to light-greenish-gray (5*GY* 8/1); weathers same colors; very fine grained; evently laminated; some very thin to thin-bedded parts; weathers to form slope. A few ¼–1-in. purplish and greenish silty very fine grained quartzite layers in lower 10 ft of unit; these layers may mark gradation into underlying unit — 42

Total of A member — 1,253

Total of Stirling Quartzite — 3,357

Johnnie Formation:

1. Siltstone, dusky-yellow (5*Y* 6/4) to light-olive-gray (5*Y* 5/2); weathers same colors; medium to coarse silt; evenly laminated; weathers to form slope. About 50 ft exposed. Contact with overlying unit sharp, but appears to be conformable — Unmeasured

Locality 66

Horse Springs section, 4 miles northwest of Horse Springs on west side of Spring Mountains, NW¼ sec. 33 and SE¼ sec. 28, T. 18 S., R. 54 E.

[Measured by J. H. Stewart and S. D. Stewart, September 1963]

Carrara Formation (incomplete): — Feet

21. Siltstone; grayish-purple (5*P* 4/2) in basal 15 ft, grayish olive (10*Y* 4/2) from 15 to 70 ft, and dusky-yellow (5*Y* 6/4) and grayish olive (10*Y* 4/2) from 70 to an estimated 150 ft; fine to coarse silt; some micaceous parts; evenly very thin bedded; weathers to form slope with small ledges. A 5-in.-thick silty fine- to medium-grained sandstone bed is 50 ft above base of unit. Thickness estimated. A brown- and gray-banded limestone about 10 ft thick overlies this unit and is overlain in turn by more siltstone that is similar to the top part of unit 21 — 150±
20. Silty sandstone, moderate-yellowish-brown (10*YR* 5/4) to light-olive-gray (5*Y* 5/2); weathers same colors; very fine grained; some fine- to medium-grained parts in lower third; indistinct thin to very thin beds; weathers to form slope — 60

Total of incomplete Carrara Formation — 210±

Zabriskie Quartzite:

19. Quartzite, pale-red (10*R* 6/2), yellowish-gray (5*Y* 8/1), and greenish-gray (5*GY* 6/1); weathers same colors; fine to medium grained; well sorted; laminated, the laminae being slightly wavy; some very low angle cross-laminae; basal 3 ft contains 0.3–0.8-ft tabular planar sets and a few small trough sets of small-scale cross-

Locality 66—Continued

Horse Springs section, 4 miles northwest of Horse Springs on west side of Spring Mountains, NW¼ sec. 33 and SE¼ sec. 28, T. 18 S., R. 54 E.—Continued

	Feet
Carrara Formation (incomplete)—Continued	
Zabriskie Quartzite—Continued	
19. Quartzite, pale-red (10*R* 6/2), etc.—Con. laminae. Unit weathers to form prominent ledge. Basal 6 in. of unit is a conglomeratic sandstone lens containing quartz pebbles as large as 33 mm in maximum diameter; a few granules occur in top 3 in. of unit. Locally pebbles occur at top of unit; the largest pebble noted is 45 mm in diameter. Top 3 in. of unit is grayish red (10*R* 4/2). *Scolithus* tubes are abundant in most of unit	29
Total of Zabriskie Quartzite	29
Wood Canyon Formation:	
Upper member:	
18. Sandy siltstone to silty sandstone, moderate-yellowish-brown (10*YR* 5/4) to pale-yellowish-brown (10YR 6/2), and minor amount greenish-gray (5*GY* 6/1); weather same colors; coarse silt to very fine sand; commonly contain fine- to medium-grained white mica; irregularly and indistinctly laminated to very thin bedded; weather to form slope. Unit contains many *Scolithus* tubes. Bottom 15 ft of unit contains several layers of quartzite similar to that in unit 17 and is transitional into unit 17. Unit also contains a few 6-in. to 1-ft layers of yellowish-gray (5Y 8/1) very fine grained sandstone	136
17. Quartzite (95 percent) and siltstone (5 percent). Quartzite, yellowish-gray (5*Y* 8/1); weathers same color; very fine to fine-grained; fair to good sorting; evenly laminated; some very low angle cross-strata, some small-scale high-angle cross-strata. Siltstone, greenish-gray (5*GY* 8/1); weathers same color; coarse silt; ¼–2-in. layers interstratified with siltstone. Quartzite contains a few scraps of trilobites. Unit as a whole weathers to form ledge	30
16. Quartzite (60 percent), siltstone (20 percent), and dolomite (20 percent). Quartzite and siltstone; similar to that in underlying unit; quartzite commonly contains very small scale cross-strata. Dolomite, medium-gray (*N*5); weathers moderate yellowish brown (10*YR* 5/4) to dark yellowish brown (10*YR* 4/2); finely crystalline; indistinctly laminated to very thin bedded 1-in. to 2-ft layers interstratified with the quartzite and siltstone; Siltstone locally contains *Scolithus* tubes. Trilobite fragments occur locally in the quartzite. Grades in places to limy dolomite and	

Locality 66—Continued

Horse Springs section, 4 miles northwest of Horse Springs on west side of Spring Mountains, NW¼ sec. 33 and SE¼ sec. 28, T. 18 S., R. 54 E.—Continued

	Feet
Wood Canyon Formation—Continued	
Upper member—Continued	
16. Quartzite (60 percent), etc.—Continued dolomitic limestone. The carbonate rocks contain abundant pelmatozoan plates	94
15. Quartzite and siltstone. Quartzite, yellowish-gray (5*Y* 8/1) and minor amount light-brownish-gray (5*YR* 6/1); weathers same colors; very fine to fine grained; fair to good sorting; evenly laminated; some very low angle cross-laminae; 1-in. to 3-ft layers interstratified with siltstone. Siltstone, light-olive-gray (5*Y* 5/2) to grayish-olive (10*Y* 4/2); weathers same colors; fine to coarse silt; common amounts of very fine grained white mica; platy. Quartzite constitutes 50 percent of unit from 0 to 20 ft, only a few percent from 20 to 57 ft, and about 40 percent from 57 to 124 ft. Unit commonly contains *Scolithus* tubes in the siltstone; lowest occurrence of *Scolithus* in place is about 60 ft above base of unit. Trilobite fragments common in the quartzite. The lowest occurrence of trilobite fragments in place is about 100 ft above base of unit. Microripples, worm tracks and trails, and trilobite scratches occur locally in unit	124
14. Silty sandstone to sandy siltstone, moderate-yellowish-brown (10*YR* 5/4) to dark-yellowish-orange (10*YR* 6/6); weather same colors; grade from coarse siltstone to silty very fine grained sandstone; commonly contains fine-grained white mica; indistinctly evenly laminated to thin bedded; weather to form steep slope with several ledges from 100 to 180 ft above base of unit. Lower 100 ft of unit is dominantly sandy siltstone; rest of unit is dominantly silty sandstone. In a few places, individual beds are locally altered to pinkish gray (5*YR* 8/1) and weather to a similar color; these beds form light bands on the outcrop. Basal 10 ft of unit contains 2 or 3 layers, 6 in. to 2 ft thick, of quartzite similar to that in unit 13. Unit contains a few worm trails (?) and other indistinct markings in siltstone in lower 100 ft	245
Total of upper member	629
Middle member:	
13. Sandstone and quartzite (90± percent) and siltstone (10± percent). Sandstone and quartzite, pale-red (5*R* 6/2 and 10*R* 6/2) and rare pale-yellowish-brown (10*YR* 6/2); weather same colors and grayish red (5*R* 4/2); variable grain size, mostly fine	

Locality 66—Continued

Horse Springs section, 4 miles northwest of Horse Springs on west side of Spring Mountains, NW¼ sec. 33 and SE¼ sec. 28, T. 18 S., R. 54 E.—Continued

Wood Canyon Formation—Continued

Middle member—Continued *Feet*

13. Sandstone and quartzite, etc.—Continued to medium grained, commonly coarse grained, commonly very coarse grained to conglomeratic in lower 200 ft (conglomeratic parts contain granules and pebbles of quartz that are generally as large as ½ in. in diameter); poor to fair sorting; composed of 6-in. to 1-ft tabular planar and and shallow trough sets of small-scale cross-laminae; some laminated parts; rare ripple marks. Siltstone, grayish-red (5*R* 4/2); weathers same color; fine to coarse silt; commonly contains fine-grained white mica; laminated ½-in. to 2-ft layers interstratified with quartzite and sandstone. Amount of siltstone approximately as follows: 0–200 ft, 2 percent; 200–400 ft, 10 percent; 400–450 ft, 15 percent; 450–500 ft, 25 percent; 500–750, 10 percent; 750–875 ft, none present ---- 875

12. Quartzite and sandstone, some siltstone in top 10 ft. Quartzite and standstone; greenish-gray (5*GY* 6/1) and grayish orange (10*YR* 7/4) in bottom 15 ft, purplish gray (5*YR* 8/1) from 15 to 22 ft, and grayish purple (5*P* 4/2) in rest of unit; very fine to coarse grained; mostly laminated; some small-scale cross-strata. Siltstone, grayish-purple (5*P* 4/2) to grayish-red-purple (5*RP* 4/2); weathers same colors; coarse silt; grades into very fine grained sandstone; laminated 1-in. to 3-ft layers interstratified with sandstone in top 10 ft of unit. Unit as a whole weathers to form ledgy slope. Pinkish-gray layer, 15–22 ft above base of unit, forms prominent light-colored band ---- 50

Total of middle member ---- 925

Offset on top of unit 11 so that overlying units measured 500 ft north of underlying units.

Lower member:

11. Siltstone (85 percent) and quartzite (15 percent). Siltstone moderate-yellowish-brown (10*YR* 5/4) and minor amount dark-greenish-gray (5*GY* 4/1); weathers same colors; coarse silt, much of rock near boundary of coarse silt and very fine sand; common amounts of white mica; evenly laminated. Quartzite, greenish-gray (5*GY* 6/1) to yellowish-gray (5*Y* 8/1); weathers moderate yellowish brown (10*YR* 5/4); very fine grained; common amounts of white mica; evenly laminated 6-in. to 2-ft layers interstratified with siltstone. Amount of quartzite appears to decrease from about 20 percent in lower part of unit to less than

Locality 66—Continued

Horse Springs section, 4 miles northwest of Horse Springs on west side of Spring Mountains, NW¼ sec. 33 and SE¼ sec. 28, T. 18 S., R. 54 E.—Continued

Wood Canyon Formation—Continued

Lower member—Continued *Feet*

11. Siltstone (85 percent), etc.—Continued 5 percent near top; however, unit is poorly exposed, and percentage of quartzite cannot be determined accurately. Unit weathers to form slope. A medium-gray (*N*5), moderate-yellowish-brown (10*YR* 5/4)-weathering limestone bed (1 ft thick) is about 15 ft above base of unit ---- 175

10. Siltstone (90 percent) and quartzite (10 percent). Siltstone, grayish-purple (5*P* 4/2), greenish-gray (5*GY* 6/1), and minor amount dark-yellowish-brown (10*YR* 4/2); weathers same colors; fine to coarse silt; common amount of white mica; laminated. Quartzite, light-brownish-gray (5*YR* 6/1) and yellowish-gray (5*Y* 8/1); weathers same colors; very fine grained; evenly laminated 1–12-in. layers interstratified with siltstone. Unit as a whole weathers to form ledge ---- 62

9. Siltstone to limy siltstone, and carbonate rock. Siltstone to limy siltstone, greenish-gray (5*GY* 6/1), dusky-yellow (5*Y* 6/4), and pale-yellowish-brown (10*YR* 6/2); weather same colors; medium silt; some laminated parts. Carbonate rock, medium-gray (*N*5) to light-gray (*N*7); weathers pale yellowish brown (10*YR* 6/2) to dark yellowish brown (10*YR* 4/2); indistinct laminae to very thin beds; occurs as follows: 0–2 ft, dolomitic limestone; 54–55 ft, dolomite; and 78–80 ft sandy limestone. Unit as a whole is poorly exposed and weathers to form gentle slope ---- 41

8. Siltstone (90 percent) and quartzite (10 percent). Siltstone, dark-greenish-gray (5*GY* 4/1) to light-olive-gray (5*Y* 5/2); weathers same colors and greenish black (5*GY* 2/1); fine to coarse silt; grades into sandy siltstone; laminated; laminae slightly wavy. Quartzite, yellowish-gray (5*Y* 8/1); weathers same colors; fine grained; laminated sets ½–2 in. thick interstratified with siltstone. Unit weathers to form small ledge ---- 47

7. Siltstone to silty sandstone (95 percent) and quartzite (5 percent). Siltstone to silty sandstone, light-olive-gray (5*Y* 5/2) to dusky-yellow (5*Y* 6/4), and greenish-gray (5*GY* 6/1); weather same colors; grade from medium siltstone to silty very fine grained sandstone; common amounts of very fine grained to coarse-grained white mica; evenly laminated; some ripple marks and worm borings on bedding planes. Quartzite; same as in unit 6; occurs in layers 0.2–2 ft thick. Unit as a whole weathers to form slope ---- 313

Locality 66—Continued

Horse Springs section, 4 miles northwest of Horse Springs on west side of Spring Mountains, NW1/4 sec. 33 and SE1/4 sec. 28, T. 18 S., R. 54 E.—Continued

	Feet
Wood Canyon Formation—Continued	
Lower member—Continued	
6. Siltstone and minor amount of quartzite, very poorly exposed. Siltstone, dusky-yellow (5*Y* 6/4) to moderate-yellowish-brown (10*YR* 5/4); weathers same colors; coarse silt; common amounts of medium-grained white mica; platy. Quartzite; yellowish-gray (5*Y* 8/1) with abundant light-brown limonite spots; fine grained; laminated. Unit weathers to form gentle slope covered with abundant quartzite rubble. Unit almost entirely described from float	60
Total of lower member	698
Total of Wood Canyon Formation	2, 252
Stirling Quartzite (incomplete):	
E member (incomplete):	
NOTE: Thicknesses of units 2, 3, 4, and 5 somewhat uncertain owing to difficulty in determining dip of strata.	
5. Quartzite, yellowish-gray (5*Y* 8/1); weathers same color; fine to medium grained; a few coarse-grained parts; thin tabular planar and trough sets of small-scale cross-strata; some laminated parts; weathers to form ledge. Highest light-colored ledge in local stratigraphic sequence	85
4. Quartzite; same as unit 2	30
3. Conglomeratic quartzite and quartzite, yellowish-gray (5*Y* 8/1); weather same color; medium to very coarse grained; contain granules and pebbles (mostly quartz; a few are jasper) in much of unit (the quartz pebbles are as large as 2 1/4 in. in diameter); weather to form cliff	90
2. Quartzite, light-greenish-gray (5*GY* 8/1); weathers dominantly pale yellowish brown (10*YR* 6/2); fine grained; common amounts of medium-grained white mica; evenly laminated; weathers to form slope; covered along most of outcrop	20
1. Quartzite, yellowish-gray (5*Y* 8/1) and light-greenish-gray (5*GY* 8/1); weathers same colors; fine to medium grained and medium to very coarse grained; some conglomeratic parts; granules and pebbles of quartz (a few of jasper) as large as 1 in. in diameter; some irregularly bedded and laminated parts; some 6-in. to 1-ft sets of small-scale cross-laminae; weathers to form cliff	Unmeasured
Total of incomplete E member	225
Total of incomplete Stirling Quartzite	225

CLARK COUNTY, NEVADA

Locality 70 (section 1)

Desert Range No. 1 section, measured on west side of Desert Range about 3 miles south of Lincoln-Clark County line, lat 36°48′ N., long 115°20′ W.

[Measured by J. H. Stewart and Harley Barnes, September, 1963; October, 1964]

	Feet
Johnnie Formation (incomplete):	
Siltstone and carbonate member:	
7. Limestone, medium-gray (*N*5), very finely crystalline; fetid odor; laminated in parts; thin bedded in other parts; exposed at base of dip slope. Unit 7 is same as unit 1 of Desert Range No. 2 section (also locality 70)	Unmeasured
Lower quartzite and siltstone member:	
6. Quartzite to conglomeratic quartzite (80 percent and siltstone (20 percent). Quartzite to conglomeratic quartzite, pale-yellowish-brown (10*YR* 6/2); weather dark yellowish brown (10*YR* 4/2); medium to coarse grained (some layers have scattered granules and small pebbles of quartz); thin bedded. Siltstone, pale-olive (10*Y* 6/2) to yellowish-gray (5*Y* 7/2); fine to coarse silt; some mica; platy splitting; occurs in 0.5–2-ft layers interstratified with quartzite and conglomeratic quartzite. Unit as a whole weathers to form ridge and long dip slope. Thickness may be slightly in error owing to difficulties of measuring on a dip slope	80±
5. Siltstone (60 percent) and quartzite (40 percent). Siltstone, light-greenish-gray (5*GY* 6/1) to light-olive-gray (5*Y* 6/1); fine to coarse silt; somewhat micaceous; platy splitting. Quartzite, light-brownish-gray (5*YR* 6/1) and minor greenish-gray (5*GY* 6/1); weathers dominantly dark yellowish brown (10*YR* 4/2); very fine grained; laminated; possibly some ripple laminae; occurs in 1–10-in. layers interstratified with siltstone. Unit as a whole weathers to form slope. Two thin beds of medium-dark-gray (*N*4) (moderate-yellowish-brown (10*YR* 5/4)-weathering) dolomite occur in interval from 10 to 15 ft above base of unit	85
4. Quartzite and siltstone. Quartzite, light-olive-gray (5*Y* 6/1), olive-gray (5*Y* 4/1), and minor yellowish-gray (5*Y* 8/1) and pale-yellowish-brown (10*YR* 6/2); minor pale red (10*R* 6/2) in top 200 ft; weathers dominantly dark yellowish brown (10*YR* 4/2); fine grained in some parts and fine to medium grained in other parts; rare medium- to coarse-grained parts; laminated to thin bedded; common tabular sets of small- to medium-scale high-angle cross-strata. Siltstone, grayish-olive (10*Y* 4/2), light-olive-gray (5*Y* 6/1) to olive-gray (5*Y* 4/1), and rare greenish-gray	

Locality 70 (section 1)—Continued

Desert Range No. 1 section, measured on west side of Desert Range about 3 miles south of Lincoln-Clark County line, lat 36°48′ N., long 115°20′ W.—Continued

Johnnie Formation (incomplete)—Continued

Lower quartzite and siltstone member—Continued

	Feet
4. Quartzite and siltstone, etc.—Continued (5*GY* 6/1); coarse silt; micaceous; platy splitting in part; occurs as 1 in. to 40 ft layers interstratified with quartzite. Unit as a whole weathers to form rolling hills. A medium-dark-gray (*N*4), moderate- yellowish-brown (10*YR* 5/4)-weathering finely crystalline dolomite occurs from 525 to 527 ft above base of unit. Amount of siltstone in unit varies as follows: 0–240 ft, 30 percent; 240–440 ft, 20 percent; 440–550 ft, 50 percent; 550–590 ft, 100 percent; 590–820, 10 percent; 820–845 ft, none; 845–975 ft, 25 percent; 975–1,040 ft, 10 percent	1,040
3. Quartzite, siltstone, and prominent dolomitic sandstone near top of unit. Quartzite, very pale orange (10*YR* 8/2), pale-yellowish-brown (10*YR* 6/2), and minor light-olive-gray (5*Y* 6/1) and yellowish-gray (5*Y* 8/1); weathers mostly dark yellowish brown (10*YR* 4/2); very fine to fine grained (limy in places and these parts weather grayish orange (10*YR* 7/4)); laminated in places; structureless in many places. Quartzite constitutes most of lower 180 ft of unit and decreases in amount upwards to about 25 percent near top of unit. Some thin layers of coarse-grained quartzite occur about 110–115 ft above base of unit. Siltstone, pale-olive (10*Y* 6/2) to grayish-olive (10*Y* 4/2), and minor light-greenish gray (5*GY* 8/1); fine to coarse silt; micaceous; platy splitting; occurs in top 260 ft of unit, where it constitutes about 25 percent of strata at the base of this top 260 ft and increases in amount upwards to about 75 percent at top. A dolomitic limestone occurs from 15 to 20 ft above base of unit. A prominent pale-yellowish-brown (10*YR* 6/2), moderate-yellowish-brown (10*YR* 5/4)-weathering 10-ft dolomitic sandstone (very fine grained) occurs from 20 to 30 ft below top of unit. Parts of unit are covered along line of section. Unit measured across several probable faults and thickness could be in error by 50 ft or so. Unit as a whole weathers to form rolling slopes	440±
Total of lower quartzite and siltstone member	1,645

Offset in section at top of unit 2 so that overlying unit measured 300 ft northwest of underlying units. Top of unit 2 and base of unit 3 are faulted in most places and possibly 50 ft or less of strata may have been lost along this fault.

Locality 70 (section 1)—Continued

Desert Range No. 1 section, measured on west side of Desert Range about 3 miles south of Lincoln-Clark County line, lat 36°48′ N., long 115°20′ W.—Continued

Johnnie Formation (incomplete)—Continued

Carbonate member (incomplete):

	Feet
2. Limestone with rare dolomite, and quartzite. Limestone with rare dolomite, medium-light-gray (*N*5) to medium-dark-gray (*N*4) and very pale orange (10*YR* 8/2) to pale-yellowish-brown (10*YR* 6/2); weathers light gray (*N*7) to medium gray (*N*5), light olive gray (5*Y* 6/1), pale yellowish brown (10*YR* 6/2), grayish orange (10*YR* 6/2), moderate yellowish brown (10*YR* 5/4) and dark yellowish brown (10*YR* 4/2); very finely to medium crystalline; commonly is sandy (grains are very fine to very coarse quartz); laminated to very thin bedded; commonly has irregular stratification; some high-angle small- to medium-scale cross-laminae. Sandy limestone characteristically weathers grayish orange, moderate yellowish brown, and dark yellowish brown and forms indistinct layers 1 in. to 10 ft thick; the orange colors create a color-banded appearance locally. Perhaps 20 percent of unit is sandy limestone, mostly very fine sand, which grades into limy sandstone. Quartzite, yellowish-gray (55*Y* 8/1) to pale-yellowish-brown (10*YR* 6/2), mostly fine- to medium-grained, minor coarse-grained to very coarse grained; laminated to very thin bedded; common small-scale high-angle cross-strata. Quartzite occurs in the unit in the following positions: 58–62 ft, 88–90 ft, 100–102 ft, 305–307 ft. In addition, about 80 percent of interval from 202 to 268 ft is quartzite with minor limy sandstone. Unit as a whole weathers to form ridges and slopes. From 268 to 330 ft, unit forms prominent black ledge. Measurement crosses small fault about 50 ft above base; displacement is probably less than 5 ft. Locally sandy limestone and very coarse grained quartzite contain siliceous fragments as large as granules	340
1. Quartzite to sandstone, limestone, and siltstone. Quartzite to sandstone, pale-yellowish-brown (10*YR* 6/2) to medium-gray (*N*5); weather pale yellowish brown (10*YR* 6/2); very fine to fine grained; evenly laminated; some of sandstone is dolomitic or limy. Limestone, medium-dark-gray (*N*4); weathers same color and light olive gray (5*Y* 6/1); aphanitic to very finely crystalline; evenly laminated; minor low-angle cross-strata; occurs in top 30 ft of unit, where it constitutes about 30 percent of strata. Siltstone, light-	

Locality 70 (section 1)—Continued

Desert Range No. 1 section, measured on west side of Desert Range about 3 miles south of Lincoln-Clark County line, lat 36°48′ N., long 115°20′ W.—Continued

	Feet
Johnnie Formation (incomplete)—Continued	
Carbonate member (incomplete)—Continued	
1. Quartzite to sandstone, etc.—Continued greenish-gray (5*GY* 8/1); medium to coarse silt; platy splitting; probably constitutes about 5 percent of unit	82
Total of incomplete carbonate member	422
Total of incomplete Johnnie Formation (Desert Range No. 1 section)	2,067
Total of incomplete Johnnie Formation (Desert Range No. 1 and No. 2 sections)	5,218

Locality 70 (section 2)

Desert Range No. 2 section, measured on west side of Desert Range about 1⅔ miles south of Lincoln-Clark County line lat 36°50′ N., long 115°22′ N.

[Measured by J. H. Stewart and Harley Barnes, Sept. 15 and Oct. 20, 1963]

	Feet
Stirling Quartzite:	
24. Quartzite, pinkish-gray (5*YR* 8/1), fine- to medium-grained; some conglomeratic parts; several hundred feet thick	Unmeasured
Johnnie Formation (incomplete):	
Rainstorm Member:	
Siltstone and quartzite unit:	
23. Siltstone (50 percent) and quartzite (50 percent). Siltstone, grayish-olive (10*Y* 4/2); grayish purple (5*P* 4/2) in top 60 ft; weathers same colors; fine to coarse silt; common amounts of mica; platy splitting. Quartzite, pale-yellowish-brown (10*YR* 6/2), rare greenish-gray (5*GY* 6/1); grayish purple (5*P* 4/2) in top 60 ft; weathers same colors; very fine grained; limy in places; evenly and distinctly laminated; occurs in 0.5–6-ft layers interstratified with siltstone; most abundant in lower 140 ft of unit. Unit as a whole weathers to form steep slope. A sandy dolomite occurs from 5 to 6 ft below top of unit; this dolomite weathers moderate yellowish brown and contains scattered fine to medium quartz grains	210
Total of siltstone and quartzite unit	210
Carbonate unit:	
22. Limestone, silty limestone, limy siltstone, and siltstone, intergradational, pale-red (5*R* 5/2) to grayish-red (5*R* 4/2); weather same colors; grade from very finely crystalline limestone to micaceous coarse siltstone (limy rocks are generally	

Locality 70 (section 2)—Continued

Desert Range No. 2 section, measured on west side of Desert Range about 1⅔ miles south of Lincoln-Clark County line, lat 36°50′ N., long 115°22′ N.—Continued

	Feet
Johnnie Formation (incomplete)—Continued	
Rainstorm Member—Continued	
Carbonate unit—Continued	
22. Limestone, silty limestone, etc.—Con. pale red and silty rocks grayish red); evenly and distinctly laminated; rare very low angle cross-laminae; weather to form cliff. Unit from 0 to 315 ft contains about 50 percent limy strata (limestone to limy siltstone); from 315 to 430 ft, mostly siltstone; from 430 to 490 ft, about 50 percent limy strata; from 490 to 555 ft, mostly siltstone; from 555 to 620 ft, about 20–30 percent limy strata; from 620 to 650 ft, mostly siltstone. Strata contain common ripple marks, drag marks, and possibly flute casts	650
Total of carbonate unit	650
Siltstone unit:	
21. Dolomite, (Johnnie oolite), moderate-red (5*R* 5/4); weathers grayish orange (10*YR* 7/4); mostly very finely crystalline, but lower few feet contains common oolitic parts and a calcirudite occurs from about 2 to 3 ft above base of unit and consists of clasts of dolomite as large as 8 in. across set in dolomite matrix; evenly laminated; weathers to form prominent light-colored ledge	6
20. Siltstone, grayish-olive (10*Y* 4/2); grayish purple (5*RP* 4/2) in top 8 ft; common light greenish gray (5*GY* 8/1) and moderate yellowish brown (10*YR* 5/4) in bottom 15 ft.; weathers greenish black (5*GY* 2/1); fine to coarse silt; micaceous; platy splitting; some indication of irregular wavy laminae in places; weathers to form slope in lower 25 ft and cliff in rest of unit	70
Total of siltstone unit	76
Total of Rainstorm Member	936
Upper quartzite and siltstone member:	
19. Quartzite (90 percent) and siltstone (10 percent). Quartzite, pale-red-purple (5*RP* 6/2) and minor greenish-gray (5*GY* 6/1); weathers pale yellowish brown (10*YR* 6/2); fine to medium grained; composed of tabular planar and minor trough sets 0.5–3 ft thick of small- to medium-scale high-angle cross-laminae; minor laminated parts. Siltstone; similar to that in underlying unit; occurs in 1–6-in. layers interstratified with quartzite. Unit weathers to form ledge	28

Locality 70 (section 2)—Continued

Desert Range No. 2 section, measured on west side of Desert Range about 1⅔ miles south of Lincoln-Clark County line, lat 36°50′ N., long 115°22′ N.—Continued

Johnnie Formation (incomplete)—Continued

Upper quartzite and siltstone member—Continued — *Feet*

18. Siltstone, grayish-purple (5*P* 4/2), grayish-olive (10*Y* 4/2), and minor light-greenish-gray (5*GY* 8/1) and pale-red (10*R* 6/2); weathers dominantly grayish red (5*R* 4/2) with light bands at top and bottom; coarse silt; somewhat micaceous; platy splitting; weathers to form slope. Unit contains a few quartzite layers 1–6 in. thick; quartzite is similar to that in underlying unit — 36
17. Siltstone (60 percent) and quartzite (40 percent). Siltstone, grayish-red-purple (5*RP* 4/2); weathers same colors; coarse silt; micaceous; platy splitting; ripple marked in places. Quartzite, grayish-red-purple (5*RP* 4/2), fine- to coarse-grained (some conglomeratic quartzite in bottom 5 ft); evenly laminated; some minor small-scale cross-strata; occurs in 1–4-ft sets interstratified with siltstone. Unit gradational into unit below, but distinguished by presence of siltstone. Unit weathers to form ledgy slope — 26
16. Quartzite grading up into conglomeratic quartzite, pinkish-gray (5*YR* 8/1) to pale-red-purple (5*RP* 6/2); weather same colors; fine- to medium-grained quartzite in lower part that grades up into coarse-grained quartzite and minor conglomeratic quartzite in upper part; the conglomeratic parts contain white quartz pebbles as large as ½ in. in diameter. Unit contains mostly thin to very thin trough sets of low-angle cross-strata; some laminated parts. Unit weathers to form cliff — 73
15. Quartzite and siltstone. Quartzite, pale-red-purple 5*RP* 4/2) and rare greenish-gray (5*GY* 6/1) (fine-grained; thin tabular planar and minor trough sets of small-scale cross laminae; some laminated parts; occurs in sets of a few inches to several feet thick interstratified with siltstone. Siltstone, grayish-purple (5*P* 4/2); weathers same color; coarse silt; micaceous; platy splitting; occurs in 1-in. to 3-ft layers. Amount of siltstone in unit decreases from about 50 percent in basal part to about 10 percent in upper third of unit. Unit as a whole weathers to form steep ledgy slope. Some ripple marks in siltstone — 83
14. Siltstone, pale-olive (10*Y* 6/2) to greenish-gray (5*GY* 6/1) and rare pale-red-purple (5*RP* 6/2); weathers same colors; medium to coarse silt; micaceous; laminated; platy splitting; weathers to form reentrant or gentle slope. Unit contains a dolomite bed from 16 to 18 ft. above base; dolomite is pale yellowish brown (10*YR* 6/2), weathers moderate yellowish brown (10*YR* 5/4), is aphanitic, and is indistinctly laminated. Unit also contains a few layers of greenish-gray (5*GY* 6/1) and yellowish-gray (5*Y* 8/1) fine- to medium-grained quartzite in top 10 ft; these layers are 1–10 in. thick — 55
13. Phyllitic siltstone (60 percent) and quartzite (40 percent). Phyllitic siltstone, grayish-purple (5*P* 4/2); weathers same color; coarse silt; micaceous; platy splitting. Quartzite, grayish-red-purple (5*RP* 4/2), light-brownish-gray (5*YR* 6/1), and yellofish-gray (5Y 8/1); weathers pale yellowish brown (10*YR* 6/2); fine to coarse grained; evenly laminated; occurs in 1–10-in. layers interstratified with siltstone. Unit weathers to form slope — 43
12. Quartzite, pale-red-purple (5*RP* 6/2) to pale-red (5*R* 6/2); weathers grayish red (5*R* 4/2); fine to medium grained; rare medium-grained to very coarse grained parts. A few thin layers of granule conglomeratic quartzite in top 110 ft of unit (2–3 percent of clasts are red chert). About 60 percent of unit is composed of planar(?) sets 1 in. to 1.5 ft thick of small- to medium-scale cross-strata; rest of unit is laminated to very thin bedded. Unit is blocky splitting; weathers to form cliff. Top 12 ft of unit is pinkish gray (5*YR* 8/1) and weathers same color — 350
11. Quartzite (80 percent) and siltstone (20 percent). Quartzite, light-olive-gray (5*Y* 6/1), light-greenish-gray (5*GY* 8/1), and yellowish-gray (5*Y* 8/1); weathers pale yellowish brown (10*YR* 6/2) to dusky yellowish brown (10*YR* 4/2); fine grained; some fine- to medium-grained parts; fairly well to well sorted; laminated to very thin bedded; rare low-angle cross-laminae; platy splitting in some parts, blocky splitting in other parts. Siltstone, pale-olive (10*Y* 6/2) to grayish-olive (10*Y* 4/2); weathers same colors; coarse silt; common amounts of very fine grained white mica; platy splitting; occurs in ½–10-ft layers interstratified with quartzite. Thickest siltstone set is from 50 to 60 ft above base of unit. Basal half of unit is fairly massive and contains blocky splitting quartzite, whereas upper half of unit is less massive, contains mostly platy splitting quartzite. The amount of siltstone in the two halves is about equal. The top 4 ft of the unit consists of grayish-purple (5*RP* 4/2) coarse siltstone to fine-grained quartzite — 178
10. Siltstone and quartzite. Siltstone, grayish-olive (10*Y* 4/2), pale-red (10*R* 6/2), and light-olive-gray (5*Y* 6/1); weathers same colors; fine to medium silt; some coarse silt; some

Locality 70 (section 2)—Continued

Desert Range No. 2 section, measured on west side of Desert Range about 1⅔ miles south of Lincoln-Clark County line, lat 36°50′ N., long 115°22′ N.—Continued

Johnnie Formation (incomplete)—Continued

Upper quartzite and siltstone member—Continued — *Feet*

10. Siltstone and quartzite, etc.—Continued very fine grained mica; platy splitting. Quartzite, yellowish-gray (5Y 8/1); weathers same color; fine grained; fairly well to well sorted; laminated to thin bedded; occurs in ½–4-ft. layers in basal 25 ft. of unit; constitutes about 40 percent of this basal 25 ft of unit. Granule conglomerate occurs in several ½–1-ft layers in basal 10 ft of unit. A medium-gray (*N*5) silty limestone to limy sandy siltstone that weathers moderate yellowish brown (10*YR* 5/2) occurs from about 15 to 18 ft above base of unit — 90
9. Quartzite, grayish-red-purple (5*RP* 4/2), pale-red-purple (5*RP* 4/2) in top 28 ft; weathers same colors and grayish red (5*R* 4/2); fine to medium grained; generally fair sorting; wavy laminae to thin beds. About 10 percent of unit is coarse-grained to very coarse grained quartzite and granule and pebble conglomerate; maximum size of pebbles is ½ in. About half of unit is composed of planar(?) and minor trough sets 4 in. to 1 ft thick of small- to medium scale cross-strata; conglomerate is also cross-stratified. Unit weathers to form prominent cliff; contains a few (3 percent) 6-in. to 5-ft layers of grayish-red (5*R* 4/2) micaceous platy splitting coarse-grained siltstone. Siltstone occurs from 45 to 50 ft and from 109 to 110 ft above base of unit and in thinner sets elsewhere. Conglomeratic part is in top 113 ft of unit — 303
8. Quartzite (>90 percent) and siltstone. Quartzite, pale-red-purple (5*RP* 6/2) to grayish-red-purple (5*RP* 4/2); weathers same colors to very dusky red purple (5*RP* 2/2); fine to medium grained; fair sorting; wavy laminae to very thin beds; 30–40 percent planar(?) sets and minor trough sets of small-scale cross-strata. Siltstone, grayish-red-purple (5*RP* 4/2); weathers same color; medium to coarse silt, grading to silty very fine grained sandstone; common medium- to coarse-grained dark mica; platy splitting. Siltstone occurs in units from 46.5 to 49.0 ft, 55.0 to 62.0 ft, 97.0 to 100.0 ft, and 153 to 169 ft (75 percent siltstone, 25 percent quartzite) above base of unit and as a few very thin sets elsewhere in unit. Unit as a whole weathers to form steep slope — 169

Total of upper quartzite and siltstone member — 1,434

Locality 70 (section 2)—Continued

Desert Range No. 2 section, measured on west side of Desert Range about 1⅔ miles south of Lincoln-Clark County line, lat 36°50′ N., long 115°22′ N.—Continued

Johnnie Formation (incomplete)—Continued

Siltstone and carbonate member: — *Feet*

7. Siltstone (95 percent) and quartzite (5 percent). Siltstone, grayish-olive (10*Y* 4/2) and minor light-olive-gray (5*Y* 6/1) to light-greenish-gray (5*GY* 8/1); weathers same colors; medium to coarse silt, coarser parts containing medium- to coarse-grained white and dark mica; platy splitting. Quartzite; same as in unit 6; occurs in laminated to thin-bedded sets 6 in. to 2 ft thick. Most prominent quartzite occurs about a third of way up in unit. Unit as a whole weathers to form steep slope between cliff-forming unit above and below — 50
6. Quartzite, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1), and minor light-gray (*N*7); weathers dusky yellowish brown (10*YR* 2/2); fine to medium grained; fair sorting; laminated; some wavy laminated parts; common 4–10-in.-thick planar(?) sets of small-scale cross-strata; weathers to form cliff. Top 13 ft of unit contains a few 1–6-in. layers of light-gray (*N*7) to greenish-gray (5*GY* 6/1) coarse siltstone to very fine grained sandstone — 68
5. Dolomite, medium-light-gray (*N*6) to medium-gray (*N*5); weathers same color with some yellowish-gray (5*Y* 8/1) parts; aphanitic to very finely crystalline; some evenly laminated parts, some very thin to thin-bedded parts; locally contains blebs and stringers of quartz (secondary?); weathers to form steep whitish slope. Basal 8 ft of unit is brownish-gray (5YR 4/1) dolomite that weathers moderate yellowish brown (10*YR* 5/4). Unit from 144 to 148 ft is medium-gray (*N*5) dolomite that weathers moderate yellowish brown (10*YR* 5/4) and contains irregular blebs (¼–½ in. long dimension) of quartz. Top 7 ft of unit is mostly pale-red (10R 6/2) to yellowish-gray (5*Y* 8/1) siltstone with a few medium-gray (N5) limestone beds ½–1 in. thick that weather grayish red (10*R* 4/2); this top 7 ft is generally poorly exposed but forms a white band where well exposed. Contact with overlying unit is sharp and nongradational. Unit contains some minor tectonically contorted layers — 155
4. Siltstone to sandstone, and quartzite. Siltstone to sandstone, greenish-gray (5*GY* 6/1) to dark-greenish-gray (5*GY* 4/1); weathers same colors; medium-grained siltstone to silty very fine grained sandstone; common very fine to coarse-grained dark-green mica; evenly laminated; platy splitting; common limonite spots (limonite after pyrite). Quartzite, yellowish-gray (5*Y* 8/1) to light-greenish-gray (5*GY*

Locality 70 (section 2)—Continued

Desert Range No. 2 section, measured on west side of Desert Range about 1⅔ miles south of Lincoln-Clark County line, lat 36°50′ N., long 115°22′ N.—Continued

Johnnie Formation (incomplete)—Continued

Siltstone and carbonate member—Continued — *Feet*

4. Siltstone to sandstone, etc.—Continued 8/1); abundant light-brown spots; similar to quartzite in unit 3; some small-scale cross-strata; quartzite constitutes about 5 percent of lower 115 ft of unit and about 25 percent of rest of unit. Siltstone in upper 60 ft of unit is mostly light greenish gray (5*GY* 8/1) with abundant light-brown spots and staining along fractures; this top 60 ft weathers a light color and with overlying unit forms a prominent white band. Unit as a whole forms steep slope with cliff in middle — 228
3. Quartzite (60 percent) and siltstone (40 percent). Quartzite, greenish-gray (5*GY* 6/1) and yellowish-gray (5*Y* 8/1); common limonite spots in some parts; weathers dominantly pale yellowish brown (10*YR* 6/2); fine to medium grained; fair sorting; indistinct beds 1–10 in. thick; occurs as 6-in. to 4-ft layers interstratified with siltstone. Siltstone; same as in unit below; occurs in layers 1 in. to 10 ft thick. Unit as a whole forms steep ledgy slope — 85
2. Siltstone, dark-greenish-gray (5*GY* 4/1 and 5*G* 4/1) and grayish-olive (5*Y* 4/2); weathers same colors; medium to coarse silt; some parts containing coarse-grained dark-green mica; common limonite after pyrite; even platy splitting probably reflecting even lamination; weathers to form steep slope. Basal 10 ft of unit is pale-brown (5*YR* 5/2) and light-brownish-gray (5*YR* 6/1) siltstone with pale-brown (5*YR* 5/2) dolomitic siltstone in top 4 in. of this 10 ft — 105
1. Limestone, medium-gray (*N*5) to dark-gray (*N*3), very finely crystalline, evenly and thinly laminated; a few 1–2-in. sets of very small scale cross-laminae (cross sections of ripples?); weathers to form prominent black slope with minor ledges. Basal 5 ft of unit is yellowish-gray limestone that weathers grayish orange (10*YR* 7/4); this grayish-orange layer forms prominent color band. Some very thin layers of grayish-orange limestone occur in top 10 ft of unit. A 1-in. layer of sandy limestone occurs about 25 ft above base; this layer contains fine to medium rounded quartz grains. Limestone in places contains flat pieces of gray to greenish-gray siltstone(?) about ⅛–¼ in. in diameter. Unit is same as unit 7 of Desert Range No. 1 section (also loc. 70). Unit overlies a unit about 1,000 ft thick of quartzite, siltstone, and rare carbonate — 90

Total of siltstone and carbonate member — 781

Total of incomplete Johnnie Formation — 3,151

Locality 71 (section 3)

Desert Range No. 3 section, measured in Desert Range about 8 miles south of Lincoln-Clark County line, lat 36°44′ N., long 115°22′ W.

[Measured by J. H. Stewart and Harley Barnes, October 1963; October 1964]

Wood Canyon Formation (see description in Desert Range No. 4 section).

Stirling Quartzite (incomplete):

E member: — *Feet*

14. Quartzite, pinkish-gray (5*YR* 8/1) to pale-pink (5*RP* 8/2); weathers same colors; fine to medium grained, some parts containing coarse to very coarse grains; rare (<1 percent) conglomerate parts containing clasts of white to pink quartz and rarely of red chert; granules and pebbles as large as 13 mm in diameter; evenly laminated to very thin bedded; 30–40 percent of strata composed of 3–10-in.-thick tabular planar or rare shallow trough sets of small-scale cross-laminae. Unit weathers to form prominent cliff at top of Stirling Quartzite — 470
13. Quartzite, grayish-red-purple (5*RP* 4/2); weathers same color; fine to medium grained; evenly laminated; forms purple slope. Unit contains a few layers of grayish-red-purple fine- to coarse-grained micaceous platy-splitting siltstone. A 9-in. dark-yellowish-brown-weathering grayish-red-purple dolomitic quartzite occurs at base — 34
12. Siltstone (60 percent) and quartzite (40 percent). Siltstone, grayish-olive (10*Y* 4/2), dusky-yellow (5*Y* 6/4), and greenish-gray (5*GY* 6/1); weathers same colors; fine to coarse silt; platy splitting. Quartzite, pale-yellow-brown (10*YR* 4/2) and yellowish gray (5*Y* 8/1), and greenish gray (5*GY* 6/1) from 52 to 87 ft above base; weathers same colors; fine to medium grained; evenly laminated; some low-angle cross-laminae; occurs in layers 1 in. to 9 ft thick interstratified with siltstone. Unit weathers to form slope. Contains one 6-in. medium-gray (*N*5) (light-brown(5*YR* 6/4)-weathering) dolomite at 30 ft and another at 34 ft — 87
11. Quartzite and limy sandstone. Quartzite, yellowish-gray (5*Y* 8/1), very light gray (*N*8), and rare pinkish-gray (5*YR* 8/1); weathers dominantly yellowish gray (5*Y* 8/1); fine to medium grained; evenly laminated; sparse small-scale cross-strata. Limy sandstone, pale-yellowish-brown (10*YR* 6/2), moderate-yellowish-brown (10*YR* 5/4), and light-gray (*N*7); weathers moderate yellowish brown (10*YR* 4/2); composed of fine to coarse sand set in calcite matrix, which constitutes about 25 percent of rock; limy sandstone at top of unit contains rare quartz pebbles as large as 16 mm

Locality 71 (section 3)—Continued

Desert Range No. 3 section, measured in Desert Range about 8 miles south of Lincoln-Clark County line, lat 36°44′ N., long 115°22′ W.—Continued

Stirling Quartzite (incomplete)—Continued E member—Continued	Feet
11. Quartzite and limy sandstone, etc.—Con. in diameter; evenly laminated and common small-scale cross-laminae. Limy sandstone occurs as follows: two thin beds from 55 to 57 ft and entire interval from 113 to 115 ft, from 123.5 to 125.0 ft, and from 133 to 135 ft above base of unit. Unit as a whole weathers to form white slope near top of middle part of Stirling Quartzite	135
10. Quartzite, grayish-red (5*R* 4/2), pinkish-gray (5*YR* 8/1), yellowish-gray (5*Y* 8/1), and light-greenish-gray (5*GY* 8/1); weathers same colors; fine to medium grained; evenly laminated; rare very low angle small-scale cross-strata. Very thin layers of light-greenish-gray and grayish-red platy-splitting coarse micaceous siltstone occur rarely in unit. Unit weathers to form light-colored ledge. Upper and lower contacts gradational. A dark-yellowish-brown-weathering limy sandstone occurs from 40 to 41 ft above base of unit	140
Total of E member	866

NOTE.—D member is absent.

C member:	
9. Quartzite, grayish-red-purple (5*RP* 4/2) to grayish-purple (5*P* 4/2); weathers same colors; fine grained and fine to medium grained; evenly laminated; sparse very low angle cross-laminae; weathers to form slope in lower part and ledgy outcrop in upper part. Lower 50 ft of unit probably contains some siltstone similar to that in underlying unit, but this part of the unit is largely covered. A dark-yellowish-brown-weathering pale-red-purple dolomitic(?) quartzite occurs from 255 to 256 ft. From 256 to 360 ft unit is cut by several faults marked by quartz veins. These faults probably are of small displacement, but this is not defintely determinable	360±
8. Siltstone (90 percent) and quartzite (10 percent). Siltstone, grayish-purple (5*P* 4/2) to pale-red-purple (5*RP* 4/2), and sparse light-greenish-gray (5*GY* 8/1); coarse silt, minor amount of fine to medium silt; micaceous; platy splitting. Quartzite, grayish-purple (5*P* 4/2) and sparse pinkish-gray (5*YR* 8/1), fine-grained, evenly laminated; occurs in layers 1–6 in. thick interstratified with siltstone. Unit weathers to form slope. Upper part of unit is poorly exposed; contact with overlying unit probably gradational	155

Locality 71 (section 3)—Continued

Desert Range No. 3 section, measured in Desert Range about 8 miles south of Lincoln-Clark County line, lat 36°44′ N., long 115°22′ W.—Continued

Stirling Quartzite (incomplete)—Continued C member—Continued	Feet
7. Siltstone (60 percent) and quartzite (40 percent). Siltstone, grayish-red-purple (5*RP* 4/2) to grayish-red (5*P* 4/2); weathers same colors; fine to coarse silt; micaceous; platy splitting. Quartzite, grayish-red (5*R* 4/2); weathers same color; fine grained; evenly laminated; occurs in 1–6-in. layers interstratified with siltstone. Unit weathers to form slope	90
Total of C member	605±

B member:	
6. Quartzite (80 percent) and siltstone (20 percent). Quartzite, grayish-red (5*R* 4/2) and minor amount of pinkish-gray (5*YR* 8/1) and greenish-gray (5*GY* 6/1); weathers same colors; mostly very fine to fine grained, some medium grained; evenly laminated. Siltstone, grayish-red (5*R* 4/2); fine to medium silt; micaceous; platy splitting; occurs in ¼–8-in. layers interstratified with quartzite. Unit gradational with overlying and underlying units	90
5. Quartzite; similar to underlying unit except it contains many prominent beds, 0.5–3 ft thick, of pinkish-gray (5YR 8/1) quartzite; these beds form prominent light-colored bands on outcrop. Unit also appears to contain more grayish-red (5*R* 4/2) micaceous coarse siltstone than underlying unit; it perhaps contains about 5 percent siltstone	123
4. Quartzite, grayish-red-purple (5*RP* 4/2) to grayish-red (5*R* 4/2); weathers same colors; grades from very fine grained to medium grained; mostly fine to medium grained; evenly laminated (laminae are very distinct); weathers to form slope. Unit contains two prominent yellowish-gray (5*Y* 8/1) quartzite layers from 100 to 120 ft above base and a few other thin beds of this color elsewhere in unit; also contains a very few light-greenish-gray (5*GY* 8/1) and grayish-red (5*R* 4/2) siltstone layers 1 in. to 1 ft thick. Unit could contain concealed faults of small offset, although none were noticed	430
Total of B member	643

A member:	
3. Quartzite, pinkish-gray (5*YR* 8/1), grayish-red (5*R* 4/2), yellowish-gray (5*Y* 8/1), and light-greenish-gray (5*GY* 8/1); weathers same colors; generally fine to coarse grained; some very coarse grained layers	

Locality 71 (section 3)—Continued

Desert Range No. 3 section, measured in Desert Range about 8 miles south of Lincoln-Clark County line, lat 36°44′ N., long 115°22′ W.—Continued

Stirling Quartzite (incomplete)—Continued
A member—Continued *Feet*
3. Quartzite, pinkish-gray, etc.—Continued and conglomerate layers in basal 15 ft (conglomerate contains quartz pebbles as large as 18 mm in maximum diameter); evenly laminated to very thin bedded; minor very low angle cross-strata; weathers to form light-colored slope. Unit is gradational into overlying unit; contains a few (<1 percent) light-greenish-gray siltstone layers about ¼ in. thick ---------- 100

Offset in section so that unit 3 measured 500 ft south of unit 2.

2. Quartzite, grayish-purple (5*P* 4/2) to medium-gray (*N*5); some very pale orange (10*YR* 8/2) in top 100 ft; basal 350 ft mostly pinkish gray (5*YR* 8/1), pale red (10*R* 6/2), and very pale orange (10*YR* 8/2); fine to medium grained to very coarse grained; about 5 percent conglomeratic quartzite to conglomerate with granules and small pebbles of quartz, to a lesser extent of quartzite, and rarely of jasper; laminated to thin bedded; common thin tabular planar sets of high-angle cross-strata; weathers to form cliff. Unit contains a few light-greenish-gray (5*GY* 8/1) micaceous very fine grained quartzite layers about ¼–3 in. thick. Some grayish-purple micaceous siltstone layers 1–2 ft thick also occur. Basal 300 ft of unit contains several faults. The offset on these faults is considered to be minor, although this cannot be demonstrated. Top 600 ft of unit, however, is unfaulted where measured. Thickness probably within 100 ft of being correct ---------- 910±

Total of A member ---------- 1,010±

Total of incomplete Stirling Quartzite ---------- 3,124

Johnnie Formation:
Rainstorm Member:
Siltstone and quartzite unit:
1. Quartzite and minor siltstone. Quartzite, pale-yellowish-brown (10*YR* 6/2) and grayish-red (5*R* 4/2), very fine grained, evenly laminated. Siltstone, greenish-gray (5*GY* 6/1) to pale-olive (10*Y* 6/2); fine to coarse silt; platy splitting. Unit as a whole weathers to form slope. A 1.5-ft dolomite layer occurs in top few feet of unit, although its exact position cannot be determined owing to cover and minor structural contortion at top of unit; this dolomite is medium gray (*N*5) to grayish red (5*R* 4/2), weathers moderate yellowish brown (10*YR* 4/2), and is

Locality 71 (section 3)—Continued

Desert Range No. 3 section, measured in Desert Range about 8 miles south of Lincoln-Clark County line, lat 36°44′ N., long 115°22′ W.—Continued

Johnnie Formation—Continued
Rainstorm Member—Continued
Siltstone and quartzite unit—Continued *Feet*
1. Quartzite and minor siltstone, etc.—Con. aphanitic to very finely crystalline. Unit probably at least 100 ft thick and is same as unit 23 of Johnnie Formation in Desert Range No. 2 section ---------- Unmeasured

Locality 71 (section 4)

Desert Range No. 4 (part) section, measured in Desert Range about 8 miles south of Lincoln-Clark County line, lat 36°44′ N., long 115°21′ W.

[Measured by J. H. Stewart and Harley Barnes, Oct. 26 and 27, 1963]

Carrara Formation (incomplete): *Feet*
20. Siltstone, grayish-olive (10*Y* 4/2) and greenish-gray (5*GY* 6/1); weathers same colors; fine to medium silt; platy splitting; weathers to form slope. Unit contains a few 1–3-in. greenish-gray (5*GY* 6/1) silty very fine to medium-grained quartzite layers in basal 30 ft. A brown-weathering very fine grained silty sandstone layer a few inches thick occurs at 65 ft. Lowest very thin interlayers of limestone occur at 95 ft, and lowest detrital limestone containing trilobite fragments and *Girvanella* occurs at 113 ft. A color change from dominantly greenish-gray(5*GY* 6/1)-weathering siltstone to pale-olive(10*Y* 6/2)-weathering siltstone occurs at 65 ft ---------- Unmeasured
19. Quartzitic siltstone to quartzite, grayish-red (5*R* 4/2); weather same color; coarse silt to very fine sand; evenly laminated to very thin bedded; weather to form ledge. One 4-in. layer in middle of unit of fine- to coarse-grained sandstone. Some ripple marks in upper 5 ft. Unit is probably 60 percent siltstone and 40 percent sandstone, although types are completely intergradational ---------- 23
18. Quartzite (70 percent) and siltstone (30 percent). Quartzite, greenish-gray (5*GY* 6/1) and minor pale-yellowish-brown (10*YR* 6/2); weathers same colors and dark-yellowish brown (10*YR* 4/2); very fine to fine grained; micaceous; evenly laminated. Siltstone, grayish-olive (10*Y* 4/2) to greenish-gray (5*GY* 6/1); fine to coarse silt; platy splitting; occurs as 1-in. to 5-ft layers interstratified with quartzite. Unit weathers to form knoll ---------- 30
17. Siltstone, dusky-yellow (5*Y* 6/4); weathers same color; fine silt; micaceous; no visible stratification; irregular splitting; weathers to form slope. Bottom foot is grayish-purple (5*P* 4/2) platy splitting coarse-grained siltstone ---------- 10

Total of incomplete Carrarra Formation ---------- 63

Locality 71 (section 4)—Continued)

Desert Range No. 4 (part) section, measured in Desert Range about 8 miles south of Lincoln-Clark County line, lat 36°44′ N., long 115°21′ W.—Continued

	Feet
Zabriskie Quartzite:	
16. Quartzite, pinkish-gray (5*YR* 3/1) to pale-red (5*R* 6/2); weathers same colors; medium to coarse grained; indistinctly laminated to very thin bedded; minor small-scale cross-strata (dipping about N. 65° W.); weathers to form ledge. Unit contains a few grayish-purple (5*P* 4/2) siltstone layers ¼–2 in. thick	6
Total of Zabriskie Quartzite	6
Wood Canyon Formation:	
Upper member:	
15. Siltstone (50 percent) and quartzite (50 percent). Siltstone, grayish-olive (10*Y* 4/2) and pale-yellowish-brown (10*YR* 6/2); weathers same colors; fine to medium silt; some coarse silt; platy splitting. Quartzite, pale-yellowish-brown (10*YR* 6/2) and yellowish-gray (5*Y* 8/1); weathers same colors; very fine to fine grained; evenly laminated; occurs as 1-in. to 3-ft layers interstratified with siltstone. Unit weathers to form slope. Unit contains common *Scolithus* tubes that increase in amount upward in unit. A 4–in. limy quartzite with a conical fossil (archeocyathid?, *Hyolithes?*) occurs at 37 ft above base of unit. Several dolomitic quartzite layers occur from 49 to 53 ft above base	133
14. Siltstone and dolomite. Siltstone; same as in unit 9. Dolomite, pale-yellowish-brown (10*YR* 6/2) to dark-yellowish-brown (10*YR* 4/2); weathers moderate yellowish brown (10*YR* 5/4); composed of medium-sized oolites; common pelmatozoan plates; occurs in a 0.5-ft-thick layer at base of unit and a 1-ft layer at top. Unit weathers to form slope	6
13. Siltstone (80 percent) and quartzite (20 percent); similar to unit 9. Siltstone contains many tracks and trails and a few *Scolithus* tubes. Quartzite locally contains sparse trilobite fragments	33
12. Quartzite to siltstone, and dolomite. Quartzite to siltstone, grayish-purple (5*P* 4/2), and some greenish-gray (5*GY* 6/1) siltstone layers; fine grained; some very fine grained parts; mostly quartzite that grades to coarse siltstone; evenly laminated. Dolomite, pale-yellowish-brown (10*YR* 6/2); weathers moderate yellowish brown (10*YR* 5/4); coarsely crystalline; abundant pelmatozoan plates; occurs in four layers 0.5–1.5 ft thick—one at base, one in middle, and two near top of unit. Unit weathers to form slope	13
11. Siltstone (80 percent) and quartzite (20 percent); same as unit 9. *Scolithus* tubes common in siltstone; trilobite fragments rare in quartzite. Same grayish-purple (5*P* 4/2) quartzite in top 2 ft	51

Locality 71 (section 4)—Continued

Desert Range No. 4 (part) section, measured in Desert Range about 8 miles south of Lincoln-Clark County line, lat 36°44′ N., long 115°21′ W.—Continued

	Feet
Wood Canyon Formation—Continued	
Upper member—Continued	
10. Quartzite (60 percent) and siltstone (40 percent). Quartzite, yellowish-gray (5*Y* 8/1) to greenish gray (5*GY* 6/1); weathers same colors and dark yellowish brown (10*YR* 4/2); very fine to fine grained; evenly laminated; some 1–4-in.-thick sets of small-scale cross-strata. Siltstone; same as in underlying unit; occurs in layers 1 in. to 3 ft thick. Trilobite scraps common in quartzite in middle third of unit. One 2-ft coarse-grained quartzite in middle of unit. Some *Scolithus* in siltstone and quartzite in basal 5 ft of unit	45
9. Siltstone and quartzite. Siltstone, grayish-olive (10*Y* 4/2); weathers same color; fine to coarse silt; locally grades to silty very fine grained sandstone; some laminated parts; platy to blocky splitting. Quartzite, yellowish-gray (5*Y* 8/1) to pale-yellowish-brown (10*YR* 6/2); weathers same colors; very fine to fine grained; evenly laminated; blocky splitting. Unit weathers to form slope. Quartzite constitutes about 5 percent of lower half of unit and increases in amount upward to nearly 30 percent near top. Top 30 ft of unit contains some *Scolithus* tubes in siltstone. Some microripples and trilobite scratches (the latter in upper part)	250
Total of upper member	531
Offset on top of unit 8 so that overlying units measured on first ridge to south (about 1,500 ft. to south).	
Middle member:	
8. Quartzite and minor siltstone. Quartzite, grayish-red (5*R* 4/2) to pale-red (5*R* 6/2); weathers the former color; all rock types from conglomerate to very fine grained quartzite; conglomerate and conglomeratic quartzite constitute about 20 percent of lower 70 ft. of unit and are generally associated with fine-grained to very coarse grained quartzite; grain size generally decreases upward in unit and is mostly very fine to fine in upper part of unit; quartzite is composed of very thin trough sets of small-scale cross-laminae; a few tabular planar sets; some evenly laminated parts. Siltstone, grayish-purple (5*P* 4/2) to grayish-red (5*R* 4/2); weathers same colors; medium to coarse silt; some mica; evenly laminated; platy splitting; occurs as 1-in.- to 5-ft.-thick layers interstratified with quartzite; constitutes about 5 percent of lower 70 ft. of unit and increases generally in amount upwards in unit to about 30 percent near top. Unit weathers to form cliffy middle part of Wood Canyon Formation	935

Locality 71 (section 4)—Continued

Desert Range No. 4 (part) section, measured in Desert Range about 8 miles south of Lincoln-Clark County line, lat 36°44′ N., long 115°21′ W.—Continued

Wood Canyon Formation—Continued

Middle member—Continued | Feet

7. Siltstone (70 percent) and quartzite (30 percent). Siltstone, dark-greenish-gray (5*GY* 4/1); weathers greenish black (5*GY* 2/1); coarse silt, grading to very fine sand; evenly laminated. Quartzite, dark-greenish-gray (5*GY* 4/1) to light-greenish-gray (5*GY* 8/1); weathers greenish black (5*GY* 2/1); very fine grained to medium grained; evenly laminated; some trough sets of small-scale cross-laminae; occurs in units 1 in. to 3 ft thick interstratified with siltstone and increases in amount upward. Unit weathers to form slope — 80
6. Quartzite (80 percent) and siltstone (20 percent). Quartzite, greenish-gray (5*GY* 6/1) to yellowish-gray (5*Y* 8/1); weathers same colors; fine to medium grained; minor medium- to coarse-grained parts; some parts are evenly laminated; some parts composed of tabular planar and trough sets of small-scale cross-laminae. Siltstone, dark-greenish-gray (5*GY* 4/1) to light-olive-gray (5*Y* 6/1); weathers same colors; coarse silt, grading to very fine sand; laminated; occurs in ½–4-in. layers interstratified with quartzite. Unit weathers to form ledge; locally forms basal part of ledgy outcrop in the middle of the Wood Canyon Formation — 42

Total of middle member — 1,057

Lower member:

5. Siltstone (80 percent) and quartzite (20 percent); same as unit 1 — 78
4. Siltstone (90 percent) and dolomite (10 percent). Siltstone, grayish-red-purple (5*RP* 4/2) to grayish-purple (5*P* 4/2); weathers dark yellowish brown (10*YR* 4/2); fine to medium silt; platy splitting. Dolomite, light-olive-gray (5*Y* 6/1) to greenish-gray (5*GY* 6/1); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline (almost aphanitic); evenly laminated; occurs in ¼–3-in. layers interstratified with siltstone; grades to dolomitic siltstone. Unit weathers to form slope that is commonly brown — 17
3. Siltstone (90 percent) and quartzite (10 percent); similar to unit 1. About a fourth of the siltstone is grayish purple (5*P* 4/2), and some of the quartzite is that color. Several pale-yellowish-brown (10*YR* 6/2) (moderate-yellowish-brown (10*YR* 5/4)-weathering) dolomite and dolomitic siltstone layers ½–4 in. thick occur from 30 to 33 ft above base of unit. Unit weathers to form slope — 93
2. Siltstone (80 percent) and dolomite (20 percent). Siltstone; same as unit below; sparse grayish-red (5*R* 4/2) parts. Dolomite, medium-light-gray (*N*6), pale-yellowish-brown (10*YR* 6/2), and light-olive-gray (5*Y* 6/1); weathers moderate yellowish brown (10*YR* 5/4); very finely crystalline; indistinctly laminated; occurs in ½–8-in. layers interstratified with siltstone. A few very thin quartzite layers, similar to those in underlying unit, occur in top 5 ft of unit. Unit weathers to form slope that is locally a distinct brown color — 30
1. Siltstone (80 percent) and quartzite (20 percent). Siltstone, grayish-olive (10*Y* 4/2) and greenish-gray (5*GY* 6/1); weathers same colors and dusky yellow (5*Y* 6/4); fine to coarse silt; micaceous; laminated; platy splitting. Quartzite, yellowish-gray (5*Y* 8/1) and greenish-gray (5*GY* 6/1); weathers same colors; very fine to fine grained; well sorted; evenly laminated; occurs as 1–8-in. layers interstratified with siltstone. Unit weathers to form slope — 225

Total of lower member — 443

Total of Wood Canyon Formation — 2,031

Stirling Quartzite:

Pinkish-gray and grayish-purple conglomerate and quartzite — Unmeasured

Locality 73

Las Vegas Range No. 2 section, measured about 2 miles northeast of Quail Spring, northeastern part sec. 14 (unsurveyed), northwestern part sec. 13 (unsurveyed), T. 17 S., R. 61 E.

[Measured by J. H. Stewart, April 1965]

Carrara Formation (incomplete): | Feet

11. Siltstone, dusky-yellow (5*Y* 6/4) and brownish-gray (5*YR* 4/1); mostly fine silt; some very thin layers of micaceous coarse-grained siltstone; platy splitting; weathers to form slope. Unit not measured but appears to be 150–175 ft thick. Unit overlain by prominent thick limestone. Upper part of unit contains some limestone layers, the lowest of which is 60 ft (actual measurement) above base of unit and is 1 ft thick; this limestone is medium gray (*N*5) and grayish orange (10*YR* 7/4) and contains *Girvanella* and fragments of trilobites — Unmeasured
10. Quartzite and siltstone, very poorly exposed. Quartzite, dusky-yellow (5*Y* 6/4), medium-gray (*N*5), and dark-yellowish-brown (10 *YR* 4/2), very fine

Locality 73—Continued

Las Vegas Range No. 2 section, measured about 2 miles northeast of Quail Spring, northeastern part sec. 14 (unsurveyed), northwestern part sec. 13 (unsurveyed), T. 17 S., R. 61 E.—Continued

	Feet
Carrara Formation (incomplete)—Continued	
10. Quartzite and siltstone, etc.—Con. to fine-grained; micaceous in places; laminated; platy splitting in part. Siltstone, light-olive-gray (5*Y* 5/2) and brownish-gray (5*YR* 4/1); fine silt; micaceous; platy splitting. Unit weathers to form gentle slope. Float of siltstone only occurs prominently in top 10 ft of unit, but siltstone probably also occurs elsewhere in unit. Relative amount of siltstone and quartzite impossible to determine, but I would guess that siltstone is at least half of unit	50
Total of incomplete Carrara Formation	50
Zabriskie (?) Quartzite:	
9. Quartzite, very pale orange (10*YR* 8/2) to pale-yellowish-brown (10*YR* 6/2), and minor dusky-yellow (5*Y* 6/4), medium- to coarse-grained; some very coarse grains; laminated to very thin bedded in places; possible very low angle cross-strata; weathers to form small ridge. Top 3 ft of unit is more vitreous and forms prominent very pale orange ledge. Some parts of unit are poorly exposed and could contain some siltstone	13
Total of Zabriskie (?) Quartzite	13
Wood Canyon Formation (incomplete):	
Upper member:	
8. Quartzite and siltsone, poorly exposed. Quartzite, yellowish-gray (5*Y* 8/1) to pinkish-gray (5*Y* 8/1), and minor pale-olive (10*Y* 6/2); and grayish-red (5*R* 4/2); weathers dominantly dark yellowish brown (10*YR* 4/2); shows as dark gray on areal photographs; very fine to fine grained; commonly silty; commonly limonite stained; laminated; a few specimens contain possible glauconite. Siltstone, dusky-yellow (5*Y* 6/4); fine to coarse silt; micaceous; platy splitting. Fine-grained siltstone occurs in top 30 ft of unit. Unit weathers to form rubble-covered slope. Most of unit is seen as float, although a few small outcrops of quartzite occur. Quartzite commonly contains worm borings and trilobite tracks. No trilobite fragments noted. A few *Scolithus* tubes noted, and some possible pelmatozoan debris noted in quartzite	150
Total of upper member	150
Middle member:	
7. Quartzite and minor siltstone; parts of unit very poorly exposed. Quartzite, greenish-gray (5*GY* 6/1, medium-light-gray (*N*6), and grayish-red (5*R* 4/2), very fine grained; may grade to coarse siltstone in places; micaceous	

Locality 73—Continued

Las Vegas Range No. 2 section, measured about 2 miles northeast of Quail Spring, northeastern part sec. 14 (unsurveyed), northwestern part sec. 13 (unsurveyed), T. 17 S., R. 61 E.—Continued

	Feet
Wood Canyon Formation (incomplete)—Continued	
Middle member—Continued	
7. Quartzite and minor siltstone, etc.—Continued in places; laminated to thin bedded. Siltstone, moderate-yellowish-brown (10*YR* 5/4); fine to medium silt; platy splitting. Unit weathers to form east-facing slope on west side of valley. A 3-ft quartzite similar to that in unit 3 occurs at 48 ft above base of unit. Unit considered to be top unit of middle member of Wood Canyon Formation, although this is difficult to determine owing to poor outcrops. Much of quartzite is finer grained than I would expect in middle member, although 3-ft quartzite at 48 ft is typical of middle member. Top of unit forms distinct break in slope, and overlying units are much more poorly exposed than unit 7	77
6. Covered	192
5. Quartzite; similar to unit 3 except mostly fine to medium grained. Sparse fragments of grayish-red siltstone (as large as a half inch in diameter) in quartzite	78
4. Covered. Units 4–6 form main part of valley	131
3. Quartzite, pale-red (5*R* 6/2) to grayish-red (5*R* 4/2), medium- to coarse-grained, laminated to thin-bedded; some low-angle(?) cross-strata; weathers to form slope. Little, if any, of rock in this unit is in place, but probably is rubble directly on top of bedrock. No lower member of the Wood Canyon Formation appears to be present on this outcrop, which was examined for about 300 ft along strike. Unit contains a few flakes of grayish-red siltstone as large as 1.5 in. in maximum diameter	45
Total of middle member	523
NOTE.—Lower member appears to be absent.	
Total of incomplete Wood Canyon Formation	673
Stirling Quartzite (incomplete):	
E member:	
2. Quartzite, very pale orange (10*YR* 8/2), fine- to medium-grained, some fine- to coarse-grained (a few thin layers contain scattered very coarse grains and granules and small pebbles); mostly very thin to thin bedded; rare low-angle cross-strata, most conspicuous cross-strata noted in lower 20 ft of unit. Approximately top foot of unit is conglomerate with granules and pebbles as large as about 1 in. of quartz and to a lesser extent of quartzite(?). Top 90 ft of unit is more vitreous than rest of unit and forms rocky and cliffy outcrops. Unit as a whole weathers to form	

Locality 73—Continued

Las Vegas Range No. 2 section, measured about 2 miles northeast of Quail Spring, northeastern part sec. 14 (unsurveyed), northwestern part sec. 13 (unsurveyed), T. 17 S., R. 61 E.—Continued

Stirling Quartzite (incomplete)—Continued

E member—Continued *Feet*

2. Quartzite, very pale orange, etc.—Continued ridge. Unit contains a few red chert (jasper) granules to coarse grains ____ 215

Total of E member ____ 215

NOTE.—D member is absent.

C member:

1. Quartzite, pile-red (5*R* 6/2) and minor yellowish-gray (5*Y* 8/1); some fine-grained parts, some fine- to medium-grained parts; commonly contains scattered coarse grains; laminated in places, but most of outcrop is too poorly exposed to determine stratification. Top of unit placed at top of highest reddish rock, but contact is difficult to locate in detail because strata near contact are poorly exposed. Contact considered to be approximately the same as that described between the C and E members (units 5 and 6) of the Stirling Quartzite in Las Vegas Range No. 1 section ____ Unmeasured

Total of incomplete Stirling Quartzite ____ 215

Locality 74

Las Vegas Range No. 1 section, measured a quarter of a mile south of Gass Spring, northwestern part sec. 4, T. 18 S., R. 61 E., and southwestern part sec. 33 (unsurveyed), T. 17 S., R. 61 E.

[Measured by J. H. Stewart, October 1964]

Stirling Quartzite (incomplete):

E member (incomplete): *Feet*

7. Quartzite, pinkish-gray (5*YR* 8/1); weathers same color and white (*N*9); mostly fine to medium grained or medium to coarse grained; some very coarse grained parts containing granules and small pebbles (as large as 7 mm) of quartz and rarely of jasper; very thin to thin bedded; rare low-angle cross-strata; weathers to form prominent light-colored ridge. Top of unit is a prominent topographic break probably marking position of a fault; alluvium occurs to west ____ 76
6. Quartzite, pinkish-gray (5*YR* 8/1) and very sparse pale-yellowish-brown (10*YR* 6/2) to yellowish-gray (5*Y* 8/1); weathers dominantly pale yellowish brown (10*YR* 6/2) to dark yellowish brown (10*YR* 4/2); fine to medium grained; some medium- to coarse-grained parts; poorly exposed but some laminated parts and sparse small-scale cross-strata; weathers to

Locality 74—Continued

Las Vegas Range No. 1 section, measured a quarter of a mile south of Gass Spring, northwestern part sec. 4, T. 18 S., R. 61 E., and southwestern part sec. 33 (unsurveyed), T. 17 S., R. 61 E.—Con.

Stirling Quartzite (incomplete)—Continued

E member (incomplete)—Continued *Feet*

6. Quartzite, pinkish-gray, etc.—Continued form rubbly slopes. Bottom 24 ft of unit is entirely pale yellowish brown (10*YR* 6/2) and appears to be a transitional sequence into unit 5. No definite dolomitic material occurs in unit; probably none is present ____ 112

Total of incomplete E member ____ 188

NOTE.—D member is absent.

C member:

5. Quartzite and minor siltstone. Quartzite, grayish-red (5*R* 4/2), and sparse pale-red (5*R* 6/2) and grayish-red (10*R* 4/2); mostly very fine to fine grained in lower half becoming coarser upward in unit; dominantly fine, medium, or coarse grained in top 120 ft of unit; laminated; sparse very low angle cross-strata; commonly contains siltstone pellets ¼–1 in. in diameter. Siltstone, grayish-red (5*R* 4/2), micaceous, platy splitting; occurs predominantly in lower half of unit; is poorly exposed and the amount of siltstone is difficult to estimate. Top 120 ft of unit contains about 40 percent yellowish-gray (5*Y* 8/1)-weathering yellowish-gray (5*Y* 8/1) and pale-red (5*R* 6/2) fine- to coarse-grained quartzite, which forms light-colored bands in generally red outcrop. Unit as a whole weathers to form low hills ____ 576
4. Very poorly exposed; appears to be predominantly siltstone. Siltstone, grayish-orange (10*YR* 7/4) to dusky-yellow (5*Y* 6/4), and minor moderate-red (5*R* 5/4); weathers the first two colors; fine to coarse silt; micaceous; platy splitting. Unit weathers to form yellowish slope at base of ridge formed by unit 3 ____ 50

Total of C member ____ 626

B member:

3. Quartzite and rare (2 percent) siltstone. Quartzite, pale-red (5*R* 6/2) to grayish-red (5*R* 4/2), and very pale orange (10*YR* 8/2) to pale-yellowish-brown (10*YR* 6/2) and light-brown (5*YR* 6/4 and 5*YR* 5/6); colors mostly interstratified forming variegated unit; grain size variable from very fine to very coarse; very thin to thin layers of very fine grained quartzite are commonly interstratified with very thin to thin layers of coarse-grained quartzite; laminated; sparse low-angle

Locality 74—Continued

Las Vegas Range No. 1 section, measured a quarter of a mile south of Gass Spring, northwestern part sec. 4, T. 18 S., R. 61 E., and southwestern part sec. 33 (unsurveyed), T. 17 S., R. 61 E.—Con.

	Feet
Stirling Quartzite (incomplete)—Continued	
B member—Continued	
3. Quartzite and rare, etc.—Continued cross-strata. Siltstone, grayish-red (5*R* 4/2) and light-brown (5*YR* 5/6); coarse silt; micaceous; platy splitting. Unit as a whole weathers to form minor ridge. Top 65 ft of unit contains abundant medium-grained to very coarse grained quartzite and a few very thin layers of conglomeratic quartzite with granules and small pebbles of quartz. One ripple-marked layer noted about 60 ft below top of unit	285
Total of B member	285
A member:	
2. Quartzite, yellowish-gray (5*Y* 8/1) to very light gray (*N*8), medium- to coarse-grained; minor (10 percent) conglomeratic quartzite or conglomerate with granules and pebbles of white quartz and very rarely of jasper (largest pebble noted is 1.6 in. in maximum diameter); rock is highly fractured and stratification is observed in most places; some very thin to thin beds present as well as a few very low angle cross-strata. Unit weathers to form prominent white ridge. Unit contains a minor amount of moderate-yellowish-brown (10*YR* 5/4)- to dark-yellowish-brown (10*YR* 4/2)-weathering pale-yellowish-brown (10*YR* 6/2) and grayish-red (5*R* 4/2) very fine to fine-grained quartzite; this quartzite occurs in basal 85 ft of unit along line of section and as a few 10–20-ft layers elsewhere in lower half of unit; position of these layers in unit varies considerably along outcrop because of faulting. Conceivably, basal 85 ft of unit could be uppermost part of Johnnie Formation, but this is difficult, and perhaps impossible, to prove	500(?)
Total of A member	500(?)
Total of incomplete Stirling Quartzite (thickness of A, B, and C members from Las Vegas Range No. 1 section, locality 74; thickness of E member from Las Vegas Range No. 2 section, locality 73)	1,626(?)

NOTE.—Thrust fault with Stirling Quartzite of Precambrian age over Bird Spring Formation of Mississippian, Pennslyvanian, and Permian age. Lower part of Stirling (unit 2) badly fractured and iron stained near thrust.

Locality 74—Continued

Las Vegas Range No. 1 section, measured a quarter of a mile south of Gass Spring, northwestern part sec. 4, T. 18 S., R. 61 E., and southwestern part sec. 33 (unsurveyed), T. 17 S., R. 61 E.—Con.

	Feet
Bird Spring Formation (incomplete):	
1. Limestone, light-gray (*N*7), aphanitic to very finely crystalline; some very thin to thin beds; largely structureless near top, probably owing to crystallization near thrust fault; weathers to form high ridge; only top few ft examined	Unmeasured

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