REPORT ON GEOLOGIC RECONNAISSANCE OF THE ARDEN AREA NEAR LAS VEGAS, CLARK COUNTY, NEVADA

By

J. C. Miller

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GENERAL INFORMATION

Plane table work on the Arden anticline area was started on November 26 and continued until December 20, 1944. The area covered by this investigation is between 5 and 12 miles southwest of the city of Las Vegas and generally west of the Salt Lake branch of the Union Pacific Railroad. The center of the area can be reached from the Las Vegas-Los Angeles highway (U. S. - 91), by a black-top road to Blue Diamond and its northern part by a gravel road leading therefrom to Red Rock Canyon and Willow Springs.

Available geologic information on this area consists of an unpublished report and an areal map by Longwell and Hewett drawn on the Las Vegas and Ivanpah topographic sheets, scale 1:250,000, in addition to several letter reports by consulting geologists. Bulletin 798 by Longwell, "Geology of the Muddy Mountains, Nevada," and Professional Paper 162 by Hewett, "Geology and Ore Deposits of the Goodsprings Quadrangle, Nevada," furnish information on the stratigraphy of adjacent areas.

STRATIGRAPHY

The nomenclature used is the same as given by Hewett in Professional Paper 162. Sections of the exposed rocks were examined in Frenchman Mountain and in the Muddy Mountains. The accompanying table of formations is taken from this publication.

Alluvial Deposits

The total thickness of alluvium, bolson deposits, and caliche is unknown. The caliche beds attain a thickness of 15 feet and their inclination conforms generally with the eastward slope of the valley floor. Most of the cemented material is composed of angular to rounded coarse gravel and boulders from the limestones that crop out in the area to the west.

Although Pleistocene lake deposits were observed west of the Muddy Mountains northeast of Las Vegas, the presence of lake deposits in the area under consideration was not noted.

Moenkopi Formation

The Moenkopi formation in this area appears to consist mainly of thin-bedded sandstone, shale, gypsum, and limestone more or less gypsiferous. This formation occupies several square miles in the south central part of T. 21 S., R. 59 E. and north central part of T. 22 S., R. 59 E., but was observed by the writer only in section 14 of the latter township. In the Frenchman Mountain section alternating greenish and yellowish beds predominate in the upper part. The section as a whole, however, is predominantly buff in color with numerous gypsiferous beds. The thickness of beds assigned to the Moenkopi is 750 feet to 950 feet. It is separated from the Kaibab limestone by an erosional unconformity.

Kaibab Limestone

The Kaibab limestone consists of two massive gray limestone beds separated by about 50 feet of red shale, sandstone, and gypsum. The thickness of this formation varies between 410 feet and 950 feet over

widely separated areas. The gypsum or anhydrite bed has been extensively mined in the northwestern part of the area by the United States Gypsum Company. This bed is now being mined by the Blue Diamond Gypsum Company about 4 miles west of the outcrop which is shown by a chain pattern on the map. The distinguishing feature of the upper Kaibab limestone in this area appears to be an abundance of fossils mainly crinoids. In the outliers in section 29, T. 21 S., R. 60 E., and section 22, T. 22 S., R. 60 E., the beds are warped slightly and their eastward dip of 5° to 8° flattens, within a few hundred feet, to approximately the dip of the surface. The sharp face of the outliers is westward.

Supai Formation

Where exposed in the area examined, the Supai consists of red and white sands and sandy shales with a probable total thickness of 1500 feet. The uppermost bed of sandstone is thick and massively cross-bedded. The bed quarried in section 5, T. 23 S., R. 60 E., is a very pure sand composed of subangular to well-rounded quartz grains with an occasional small particle of red shale. A layer of sandstone about one-half inch thick exposed in this quarry is composed of nearly perfect quartz crystals 0.5 mm or less in cross section. This sandstone is also exposed at the base of the cliff west of the Commonwealth well.

Bird Spring Formation

The Bird Spring formation occupies most of the southern part of the area examined in reconnaissance. According to Hewett's description on pages 21 and 22 of Professional Paper 162 --

"...The formation consists essentially of limestone, shale, and sandstone, but many beds, and even large thicknesses over considerable areas, that were originally limestone have been altered to dolomite. The estimated maximum thickness of 2,500 feet includes many thin beds in the upper 1,000 feet that were doubtless originally dolomite, but it appears probable that the remaining lower part was made up wholly of limestone, shale, and sandstone. Sand is present as distinct beds, and grains of sand are uniformly distributed through many of the beds of limestone.

"The beds of limestone range from the thinnest laminae to massive layers 60 feet thick. Several of the thickest beds occur near the base, but others lie about 1,000 feet above it. There are numerous good exposures of sections 200 to 400 feet thick in which most of the beds range from 2 to 15 feet thick, whereas here and there 50-foot sections contain no beds more than a foot thick. Thus, it stands in striking contrast to the underlying massive formations. ... The beds of limestone also display a wider range in color than exists in the lower formations. Most of the beds are bluish gray, but they range from nearly black to white. Some of the higher beds in the Spring Mountains and the Bird Spring Range weather reddish brown, thereby indicating an appreciable content of iron. In general the light colors indicate the presence of dolomite, but here and there, as in sec. 32, T. 23 S., R. 58 E., alteration to dolomite has not produced any change in color.

"The limestones of the formation are uniformly fine grained or porcelainlike in texture. A few show sporadic crystalline areas that represent fragments of crinoid stems. The dolomitized beds are more coarsely crystalline. From the few thin sections that have been studied it appears that the fine texture of the limestone is due to the small size of the organisms or fragments that make them up. The dark colors are due to finely disseminated carbon and hydrocarbons, and these yield a fetid odor when the rock is broken. During the process of dolomitization the hydrocarbons were largely eliminated.

"Small quantities of chert are present persistently throughout the formation, although it is most abundant near the base. ...

"Only a few beds of clean sandstone are recorded, but many beds of apparently fine limestone contain 5 to 50 per cent of sand grains ... Weathered surfaces of such beds show cross-bedding. In the several specimens that have been examined the range in size is 0.02 to 0.10 millimeter, but in single specimens the range is much less. About 90 per cent of the grains are clear quartz, but feldspar (microperthite and plagioclase) are also present, and zircon is an accessory. The grains are largely subangular, but a few of the largest are well rounded.

"The thickest and most persistent sandstone in the formation is that which lies at the base. ... Although the outcrop of this sandstone is nowhere conspicuous, it extends throughout the region

north of Columbia Pass. Where exposed in the workings of the Yellow Pine mine it is 23 to 28 feet thick, pale yellowish brown, fine grained, and without distinct bedding. On the surface from the Contact mine northwest to the Ninety-nine mine and around Potosi Mountain to the Potosi mine it is thin bedded and distinguished by round brown markings, probably due to oxidized pyrite. For a distance of 1,200 feet near the Snowstorm mine, the sandstone zone is largely occupied by a bed of conglomerate whose maximum thickness is 10 feet. ...

"This bed of sandstone and conglomerate is not noticeably unconformable on the underlying beds, but other features indicate that it marks a persistent unconformity in the stratigraphic section. ...

"Fossils are common in the lower part of the formation and are abundant in some beds 100 to 300 feet above the base. A few beds may be recognized with assurance rather widely, not only on account of the fossil species present but by their abundance."

The Bird Spring formation where observed consists of hard gray to white limestone and dolomite with some relatively thin sandy members.

STRUCTURE

According to the Hewett-Longwell report (unpublished): "The region under discussion is structurally complex. ...Existing outcrops indicate the presence of anticlines near Arden and Sloan and others may exist under the cover of Tertiary rocks in Las Vegas valley."

In general, the main structural features of the mapped area are (1) the northwest-southeast trending Arden anticline in the northwestern part, (2) the generally east-west trending anticline west of Sloan in the southern part, and (3) the small anticlinal area east of Sloan in the southeastern part. The Arden anticline is terminated on the north by a faulted area in T. 21 S., R. 59 E. North of this faulted block, which involves members of the Kaibab and Supai formations at the surface, the Aztec sandstone is faulted down. To the south this anticline is not traceable beneath the alluvium cover but it is believed to die out in the flats west of Bard, on the north flank of the complex structural depression that separates it from the transverse Sloan anticline further south. The broader basin of which this depression appears

to be a minor part extends westward from the Kaibab escarpments approximately four miles. On the west this basin is limited by eastward dipping beds in the belt of complex north-south faulting along the east front of the Bird Spring Range.

The Sloan anticline, trending slightly south of west, at right angles to the Arden anticline, may be in part the result of igneous intrusion. This fold appears to be a subsidiary flexure on the northward sloping limb of the major structural basin that centers about the Blue Diamond camp west of the mapped area and exposes the Pennsylvanian Bird Spring formation in its southern rim.

The third anticlinal area is east of the northwest-southeast trending normal fault mapped by Longwell and Hewett a mile east of Sloan and is the smallest in extent. It modifies the relatively upthrown side of that fault to a minor degree but no attempt was made to determine its features because its surface is occupied in greater part by pre-Pennsylvanian rocks.

The proximity of former volcanic activity suggests the possibility of intrusion rather than folding as the cause of some at least of the discordant dips observed in the southern part of the Arden area. There is the additional possibility that fusion of the limestone beds by intrusive masses caused the erratic surface dips observed in some places. Some distortion of Kaibab beds might result from the swelling and change to gypsum of interbedded anhydrite subjected to weathering.

OIL AND GAS POSSIBILITIES

According to Longwell and Hewett the known anticlinal areas of the region do not appear to be favorable for the occurrence of oil and gas, as indicated by the following quotations from their unpublished report: "The Paleozoic formations of this region do not appear to be highly favorable sources for

oil and gas. ... shales and sandstones are rather highly indurated and compact; the limestones and dolomites are dense." However, these authors also state that "The only rocks in the entire Paleozoic section that are noticeably carbonaceous and yield a fetid odor when freshly fractured are found in the lower 300 feet of the Bird Spring formation. ... This zone is clearly the most favorable source for oil and gas in the entire Paleozoic section. ...

"Existing outcrops indicate the presence of anticlines near Arden and Sloan and others may exist under the cover of Tertiary rocks in Las Vegas Valley. If reservoir conditions were good and these anticlines were without faults, they might offer favorable sites for exploratory drilling, but the number and kind of faults that are known nearly discourage the prospect."

The paucity of organic shales or other likely sources of petroleum in the entire thickness of sedimentary rocks involved is a further deterrent to the expectation of consequential accumulations of oil or gas in the Arden area.

DRILLING DEPTHS

Correlation of surface exposures with the subsurface beds logged by the two wells drilled is rather difficult on the basis of present information. The Commonwealth Oil Company well, apparently higher structurally, starts in excess of 300 feet, perhaps 500 feet, below the top of the Supai formation. The well continued in the Supai to a depth of 975 feet and then entered the Bird Spring formation. Drilling was continued in that formation to the total depth of 1870 feet. According to this correlation, the entire thickness of Bird Spring formation should be penetrated in this well at a depth of 3400 to 3500 feet. Showings of gas were reported at depths of 800 to 805 feet and 1560 to 1575 feet in this well and rumors of numerous oil shows are prevalent. The Red Star-Nelson well may have started about the top of the Supai, ignoring the thickness of alluvium cover, and entered the Bird Spring formation at a

depth of 1524 feet. It is reported that well samples at the total depth of 3204 feet showed hydrocarbons on testing with carbon tetrachloride. According to the foregoing correlation and to Hewett's measurement of thickness of the Bird Spring formation, 2500 feet, the Nelson well if drilled to 3800 feet should penetrate the lower part of the Bird Spring formation, the bottom of which should occur at a depth not in excess of 4000 feet. Any wells planned for testing the lower 300 feet of the Bird Spring formation in structures near Sloan on the south should provide a drilling depth of 2500 feet, or less, depending on their location and stratigraphic position.

J. C. Miller

March 24, 1945

Formations of the Goodsprings quadrangle, Nevada

Age classification	Formation	Character (Exposed in Goodsprings quadrangle)	Thickness (feet): Spring Mtn.	Thickness (feet): Frenchman Mtn.
Recent	Alluvium.	Unconsolidated mud, sand, coarse gravel and boulders of local origin.		
Pleistocene.	Lower (later) gravel.	Cemented sand and gravel of local origin on the hills west of Goodsprings.	50-100	
	Higher (earlier) gravel.	Unconsolidated sand, coarse gravel, and boulders, largely from remote source but partly local.	50-125	
Tertiary (Miocene?)	Volcanic rocks.	Tuffs, breccia, and flows of latite andesite, rhyolite, and basalt	0-200	
Jurassic (?)	Aztec sandstone	Massive ledge of reddish or buff sandstone, minutely cross-bedded.	2,100	2,000
Upper Triassic	Chinle Formation	Reddish shaly sandstone and shale with several beds of chert and limestone conglomerate.	1,000+	700
Upper (?) Triassic.	Shinarump conglomerate.	One or two beds of limestone and chert conglomerate separated by sandy shale.	10-30	25-50
Permian.	Moenkopi formation Unconformity	Thin-bedded buff limestone underlain by green and red shale and conglomerate and overlain by red sandy shale. Tuff and conglomerate of igneous pebbles overlie the limestone member 2 miles west of Goodsprings.	750-950	1,500
	Kaibab limestone	Two massive ledges of gray limestone separated by 20 to 30 feet of buff to red shale and sandstone.	410-555+	600
	Supai formation.	Reddish sandstone separating red and greenish shaly sandstone below from red gypsum-bearing shaly sandstone above.	1,000-1,100	1,000

Pennsylvanian.	Bird Spring formation.	Gray limestone and dolomite in beds ranging in thickness from thinnest laminae to 60 feet, separated by shale and sandstone. From Goodsprings northward a conglomeratic sandstone at base.	2,500±	2,500
		Unconformity		
Mississippian (middle and lower)	Monte Cristo limestone.	Several beds of dark-gray limestone that locally weather as a massive ledge. In places completely altered to dolomite.	60-120	800
		Thin-bedded blue and gray limestone alternating with gray shale; highly fossiliferous; no chert.	10-20	
		Massive light-gray limestone, now largely altered to cream-colored and white dolomite; chert uncommon.	185-300	
		Massive gray limestone with numerous thin chert layers; in places large belts are altered to dolomite; numerous fossils.	65-400	
		Thin-bedded dark-gray limestone; little chert; in large part of area altered to dolomite; numerous fossils.	60-400	
Devonian.	Sultan limestone.	Very thin-bedded light-gray limestone; no fossils or chert.	150-260	500
		Light-gray limestone and dolomite; numerous fossils.	75-380	
		Dark-gray to black dolomite, in beds 2 to 5 feet thick; few fossils.	5-125	
Devonian (?) to Upper Cambrian	Goodsprings dolomite.	Thin-bedded light and dark gray mottled dolomite, with some magnesian limestone and locally near top 50 to 75 feet of dolomitic and sandy shale; very few fossils.	2,450±	2,000

Not exposed in Goodsprings quadrangle

Middle Cambrian.	Bright Angel shale.	Green micaceous shale and brownish sandstone; contains trails but few fossils.	240±	400
	Tapeats sandstone.	Brownish sandstone, thin bedded.	130+	125
Algonkian.		Conglomerate, quartzite, and dolomite exposed in Kingston Mountains and possibly present beneath the Paleozoic rocks of the western part of the Goodsprings quadrangle.		
Archean.		Reddish granite gneiss.		

R. 59 E.

T. 21 S.

T. 22 S.

T. 23 S.

R. 60 E.

R. 61 E.

Faulted Area

Commonwealth Oil Co. well #1

Red Star Oil Co. Nelson # 1A

Sunday Mine K.2671

Arden

Bard

Sloan

U.S. Lime Products Co.

Silica mine

To Blue Diamond

To U.S. 91

Union Pacific R.R.

U.S. 91

B.M. 2631'

B.M. 2574

B.M. 2711'

G.3141 G.3266 G.3183 G.3199 G.3129 K.3343 K.3040 K.2993 G.2962 G.3429 G.3469 G.3477 G.3403 G.3407 K.2850

Legend

- Al — Alluvium
- Mv — Miocene-Pliocene volcanic rocks
- Rm — Triassic - Moenkopi
- Ck — Permian - Kaibab
- Cs — Permian - Supai
- Cps — Pennsylvanian - Bird Spring
- Cmc — Mississippian - Monte Cristo
- Ds — Devonian - Sultan

Explanation

- Anticline
- Syncline
- Fault
- 10° — Dip and strike of formations
- Mine or quarry
- Abandoned mine
- Reported well location
- Drilling well
- Abandoned well
- Base of gypsum bed in Kaibab formation
- K.2993 — Elevation on Kaibab limestone
- G.2962 — Elevation base of gypsum bed

Columnar Section

Age	Formation and thickness (feet)	Section
Recent	Alluvium, Caliche	
Pleistocene	Later gravel 100	
Pleistocene	Earlier gravel 125	
Miocene	Volcanic rocks 0-200	
Jurassic	Aztec ss. 2100	
Triassic (Upper)	Chinle fm. 1000±	
Triassic (Upper?)	Shinarump 0-30	
Triassic (Lower)	Moenkopi fm. 750 - 950	
	Unconformity	
Permian	Kaibab fm. 410 - 950	
Permian	Supai fm. 1500	
Pennsylvanian	Bird Spring formation 2500±	
	Unconformity	
Mississippian (Middle & lower)	Monte Cristo ls. 380 - 1240	
Devonian	Sultan ls. 230 - 770	
Devonian (?) to Upper Cambrian	Goodsprings dolomite 2450±	

Formations of the Goodsprings Quadrangle, Nevada after Hewett (P.P.162)

Base map from G.L.O. plats and plane table sheet

Areal geology after unpublished data by Longwell and Hewett

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
CONSERVATION BRANCH

GEOLOGIC RECONNAISSANCE OF THE ARDEN AREA, CLARK COUNTY, NEVADA

BY

J. C. MILLER

Scale 0 1 2 3 4 5 Miles

DECEMBER, 1944

V.L.E. & R.L.

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