GROUND WATER IN PAHRUMP, MESQUITE, AND IVANPAH VALLEYS, NEVADA AND CALIFORNIA.

By Gerald A. Waring.

INTRODUCTION.

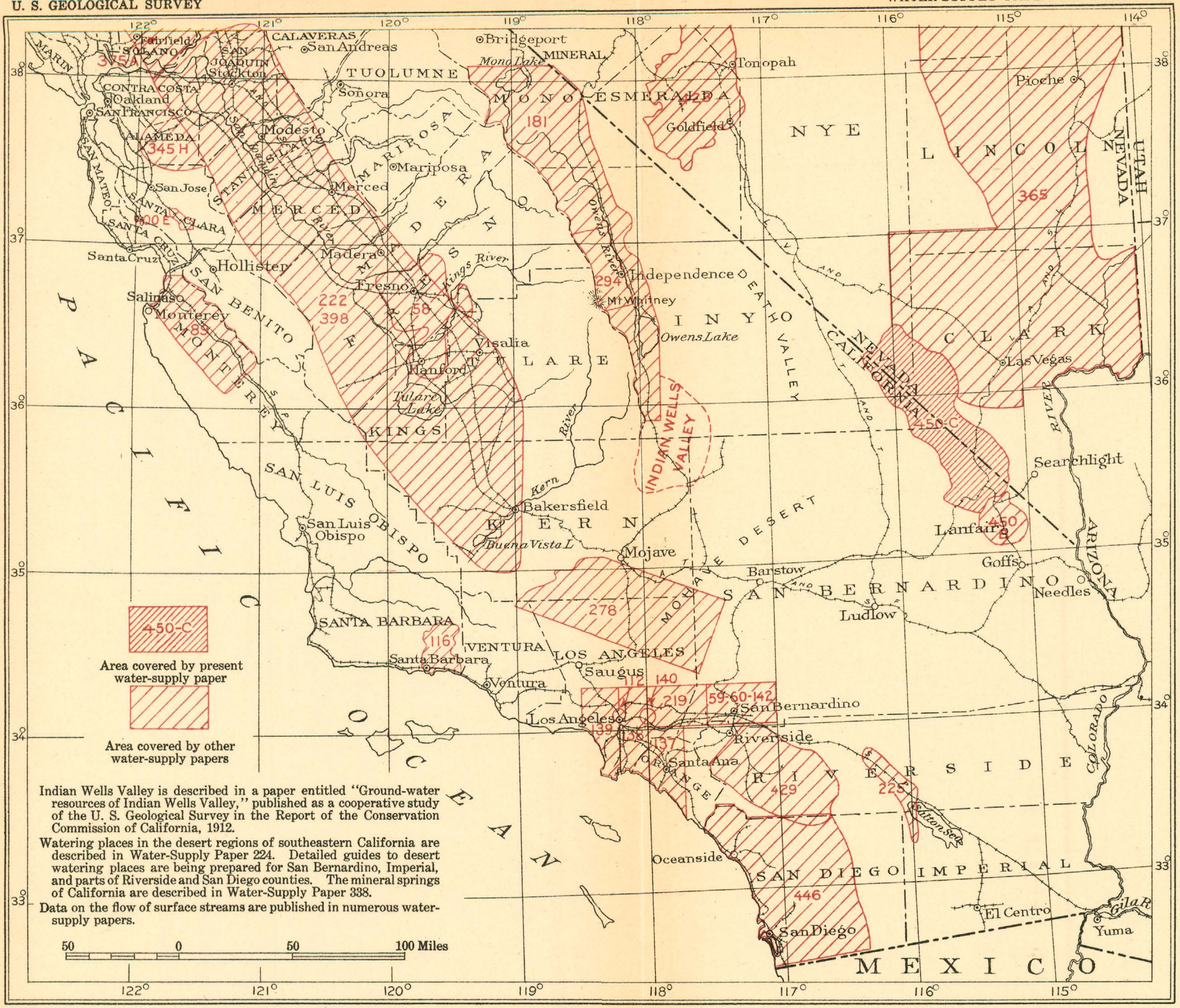
In eastern California and southern Nevada there are numerous detached drainage basins that have no outlets for their surface water. The lowest parts of these basins are occupied by clay flats which may be covered with water during wet seasons but which are dry during the greater part of the year. These flats are known as playas or "dry lakes." Pahrump, Mesquite, and Ivanpah valleys occupy three such inclosed basins, partly in Nevada and partly in California. (See Pls. VII and VIII.)

The drainage basin of Pahrump Valley is mainly in Nye and Clark counties, Nev.; a small portion of it lies in Inyo and San Bernardino counties, Calif. (See Pl. VIII.) Somewhat less than half of the drainage basin of Mesquite Valley lies in Clark County, Nev., and the remainder is in California, chiefly in San Bernardino County but partly in Inyo County. About 57 per cent of the drainage basin of Ivanpah Valley is in San Bernardino County, Calif., but the lowland as well as the bordering slopes extends northward into Clark County, Nev. The areas of the drainage basins of Pahrump, Mesquite, and Ivanpah valleys, by planimetric measurement on the topographic maps of the region, are, respectively, 1,040, 395, and 770 square miles.

There are no perennial streams of consequence in any of the basins, but numerous small springs furnish water supplies for prospectors and for range stock, and at two places in Pahrump Valley there are large springs used for irrigation. Within the last few years attempts have been made in each valley to develop supplies of water for irrigation by sinking wells. Although the preliminary tests did not result in agricultural settlement of the valley lands, attempts to develop ground water for irrigation have been continued, and the writer was assigned to make a short examination of the region, in order to determine, if possible, the relative amount of ground water available and its adaptability to successful farming. A short time in August, 1916, was spent by the writer in the examination of the valleys, in company with Ernest L. Neill, of Stanford University, who rendered able assistance in gathering information. The collection of well records and other data during the short time that could be spent in the region was greatly facilitated in Pahrump Valley by Messrs. T. G. Darrough, J. M. Raycroft, Albert Quill, Hoffman & Vetter, and T. J. Donovan; in Mesquite Valley by Mr. J. B. Cryor; and in Ivanpah Valley by Mr. Ruben Fuchner. Some additional data were collected in 1917 by D. G. Thompson, of the United States Geological Survey.

Ivanpah Valley is traversed by the Los Angeles & Salt Lake Railroad. At Cima, Ivanpah, and Nipton there are small stores and limited accommodations for travelers. Roach, a settlement of half a dozen houses, is a shipping point for ore and affords meals and accommodations for the night. Jean, the principal settlement in the valley, is a mining supply and shipping point, with a large general store, warehouse, post office, hotel, saloon, and a dozen dwelling houses. From Jean a narrow-gage railroad extends northwestward to the mining settlement of Good Springs, which in 1916 had a population of perhaps 200, and to the Yellow Pine or Bybee mine, 4 miles farther west. From Good Springs and Roach well-graded wagon roads extend to Platina, in Mesquite Valley. This town, which was started in 1914 during local excitement over the discovery of platinum in the adjacent hills, consisted in 1916 of a general store and post office and seven other houses along streets laid out about a quarter of a mile north of the former Ripley post office and an equal distance southeast of the abandoned mill of Sandy. The store and post office were discontinued, and the town was practically abandoned. At the Milford mine and other mines in the mountains east of Platina there were small groups of tents and cabins of those engaged in getting out ore. From Platina roads lead northwestward to Manse and Pahrump ranches, the principal settlements in Pahrump Valley. In 1916 Pahrump post office had mail service three times a week with Shoshone, a station 27½ miles to the southwest, on the Tonopah & Tidewater Railroad. The small mining settlement of Johnnie is near the north border of the Pahrump Valley.

The old copper smelter at Valley Wells, 20 miles northwest of Cima, was rebuilt by the Ivanpah Copper Co. late in 1917, and was in operation as late as February, 1918, when about 50 men were working there. The smelter was later reported to have been closed down. Because of fluctuations of the metal market and other conditions the future of many mining camps is very uncertain, and a traveler who is going into a region for the first time should make inquiries regarding the presence of settlers and not depend on finding people at places where settlements have flourished in the past.



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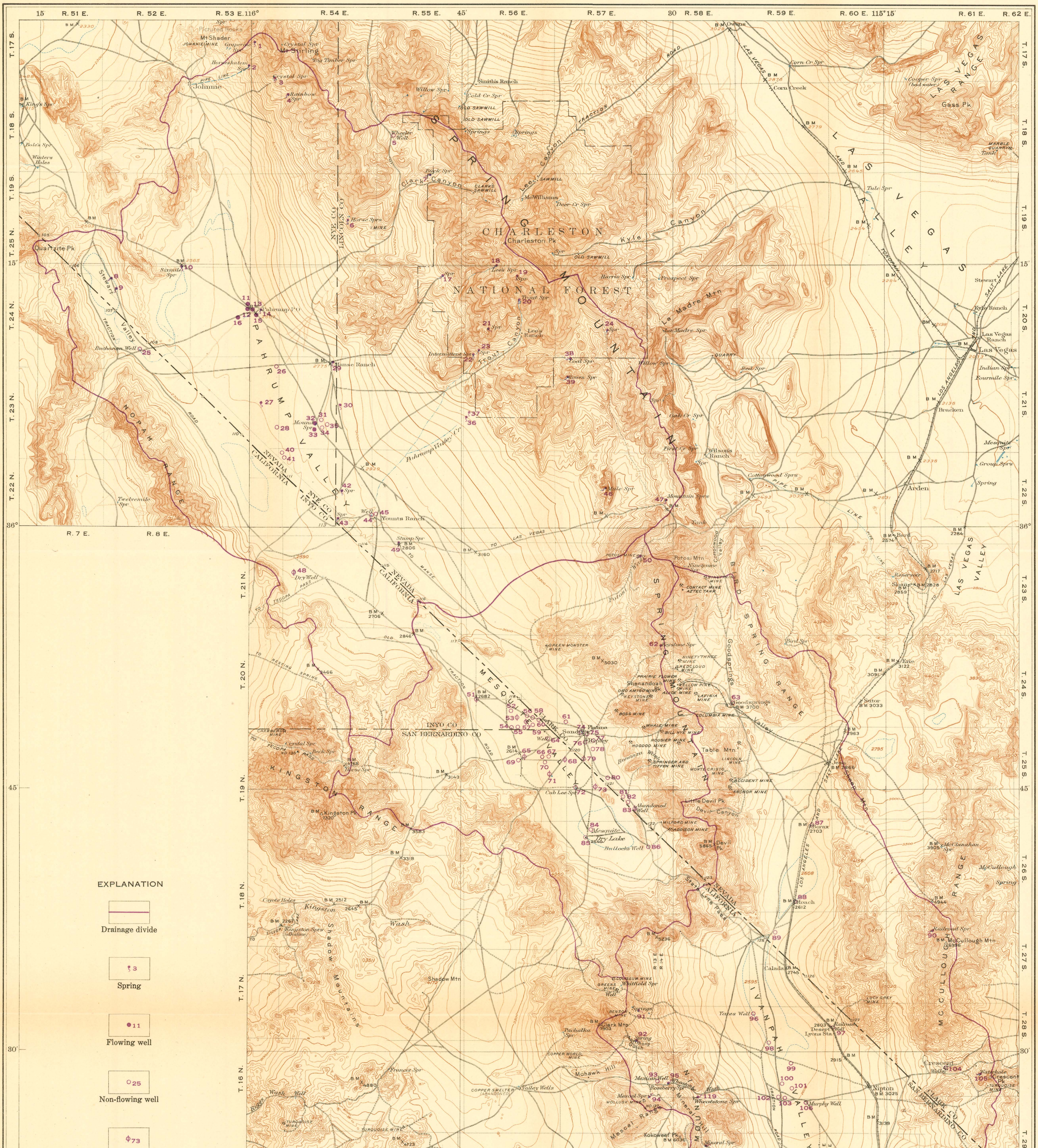
SKETCH MAP OF PARTS OF CALIFORNIA AND NEVADA

Showing areas treated in the present report and in other water-supply papers of the U. S. Geological Survey relating to ground water



Base from U. S. Geological Survey topographic maps, with minor corrections by Gerald A. Waring

MAP OF THE DRAINAGE BASINS OF PAHRUMP, MESQUITE, AND IVANPAH VALLEYS, NEVADA AND CALIFORNIA SHOWING LOCATION OF WELLS AND SPRINGS

Scale $\frac{1}{250,000}$

2 1 0 2 4 6 8 10 Miles

2 1 0 2 4 6 8 10 Kilometers

Contour interval 100 feet.
Datum is mean sea level.

1920

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Locations by Gerald A. Waring

GEOGRAPHIC SKETCH.

TOPOGRAPHY.

Spring Mountain, a range that culminates in Charleston Peak, at an elevation of 11,910 feet above sea level, is the dominant topographic feature of the region. The east side of the range is characterized by great cliffs. The west side, which is in the Pahrump drainage basin, is somewhat less precipitous and is bordered by extensive alluvial slopes. (See Pl. IX, *A*.) The lowest part of the Pahrump basin is in the northwest, in a reentrant known as Stewart Valley (Pl. IX, *B*), at an elevation of about 2,450 feet. The southwest border of the Pahrump basin is formed by the steep slopes of the Nopah Range, which rises 2,000 feet above the valley, and by subsidiary ranges to the north and south. The drainage divide between the Pahrump basin and that of Ash Meadows, to the northwest, follows the crests of several semidetached, unnamed mountains that attain elevations of 4,000 to 5,000 feet above sea level. On the southeast the Pahrump basin is separated from the Mesquite basin by a drainage divide that extends from the crest of Spring Mountain down the alluvial slopes and across the lowland as an indefinite divide, to the base of a northeastern spur of the Kingston Range.

The Mesquite drainage basin, which is rudely triangular, has its northern, southern, and western corners, respectively, near Potosi Mountain, Clark Mountain, and Kingston Peak. The highest point in the basin is Potosi Mountain, at an elevation of 8,500 feet above sea level; the lowest land is in the dry Mesquite Lake, at an elevation of about 2,535 feet. The divide on the east is formed by a southward extension of Spring Mountain; on the southwest by lower mountains. Between spurs of these mountain ranges on the east and the southwest, wide alluvial slopes extend down to the lower land at grades of 100 to 400 feet to the mile.

The western border of the Ivanpah drainage basin, which lies south of Mesquite basin, is formed by Clark Mountain (elevation, 7,903 feet) and adjacent ranges, and by Ivanpah Mountain, whose main peaks are more than 5,500 feet above sea level. On the east the limit of the drainage basin is formed in part by the crest of the Bird Spring Range, Sheep Mountain, and the McCullough Range. From the south end of the McCullough Range the divide swings southwestward along the crest of the New York Mountains. The extreme northern limit of the Ivanpah basin is definitely marked by the summit of Potosi Mountain. The extreme southwestern limit is less definitely determined by alluvial slopes on each side of the railroad pass at Cima. The lowest portion of the basin is occupied by the dry Ivanpah Lake, at an elevation of 2,595 feet, separated by a slight divide from the dry lake near Roach, whose surface is 13 feet higher.

The surface in each basin may be divided into three parts—lowland, alluvial slopes, and mountains. The approximate areas and percentages of each class are shown in the following table:

Area of land of different classes in Pahrump, Mesquite, and Ivanpah basins.

	Lowlands.		Alluvial slopes.		Mountains.		Total area of basin (square miles).
	Area (square miles).	Per cent of total area.	Area (square miles).	Per cent of total area.	Area (square miles).	Per cent of total area.	
Pahrump basin	250	24	330	32	460	44	1,040
Mesquite basin	90	23	115	29	190	48	395
Ivanpah basin	85	11	375	49	310	40	770

It will be noted that the proportion of lowland, alluvial slopes, and mountains are approximately the same in the Pahrump and Mesquite basins, but that the Ivanpah basin contains a much larger percentage of alluvial slopes than either of the other two basins, and less than half as large a percentage of lowland.

CLIMATE.

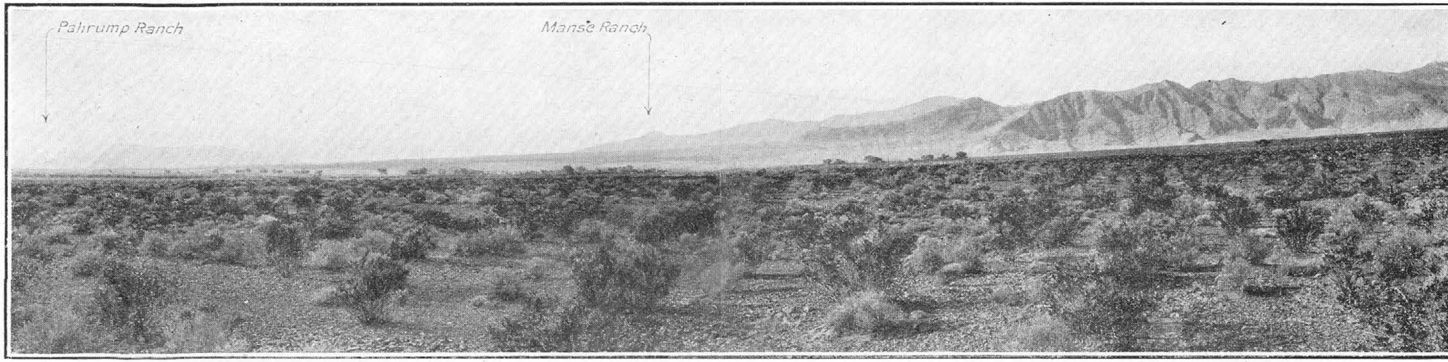
Most of the precipitation is in the winter. More than half of it falls during the four months December to March, inclusive. On the mountains much of the precipitation is in the form of snow. Occasional thunderstorms during the summer locally furnish considerable water, but they are so irregular in occurrence and are likely to be so severe that they are of relatively small value to growing crops. The following record of precipitation at Jean, in Ivanpah Valley, and at Pahrump, in Pahrump Valley, indicate the approximate monthly distribution of the precipitation in the valleys. The precipitation increases rapidly with increase of elevation.

Monthly and annual precipitation, in inches, at Jean, Nev.

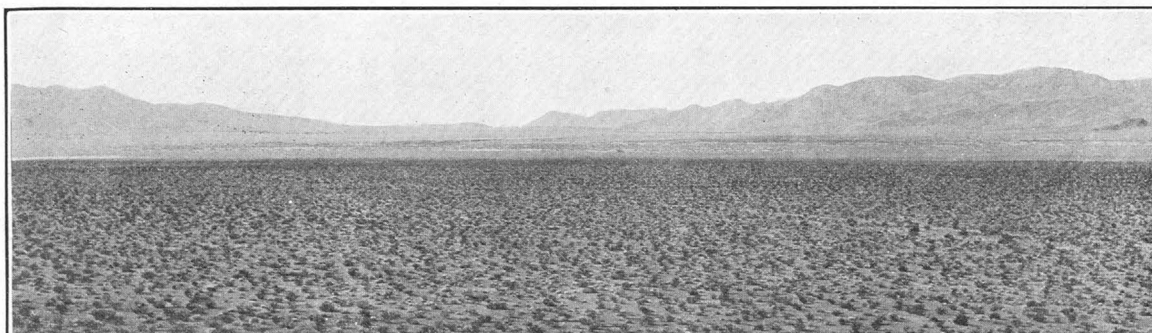
[Elevation 2,864 feet.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1908	1.30	0.10	0.20	0	Tr.	0	0.10	0.06	2.71	1.00	0	0	5.47
1909	.09	......	1.32	0.30	0	0	.03	.12	2.03	0	0.67	1.59	a 6.15
1910	0	0	0	0	0	0	2.05	1.13	.40	.60	.90	......	a 5.08
1911	.44	.75	1.00	0	0	......	Tr.	0	0	......	0	Tr.	a 2.19
1912	0	0	......	.27	.10	Tr.	.46	.20	0	.30	0	0	a 1.33
1913	.30	.40	......	.25	0	Tr.	......	.52	.23	Tr.	1.25	0	a 2.95
1914	1.50	.05	Tr.	1.25	0	Tr.	.03	0	.65	......	......	......	a 3.48
1915	1.25	1.00	.20	Tr.	Tr.	Tr.	.29	Tr.	......	......	......	......	......
1916	......	......	......	......	......	......	......	......	......	......	......	......	......

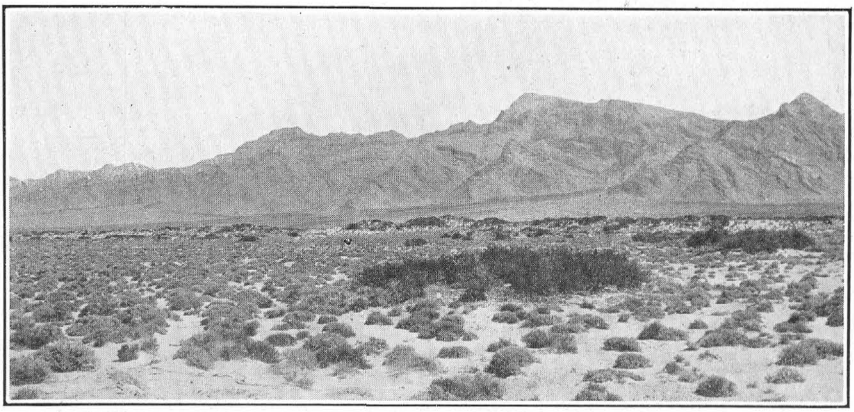
a Approximate.



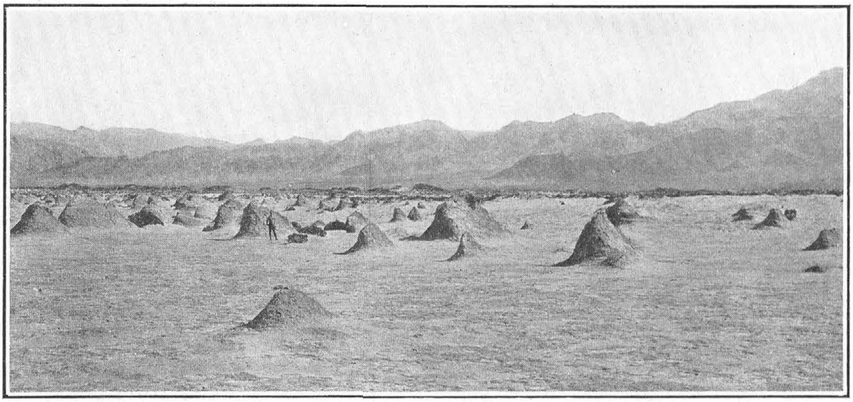
A. ALLUVIAL SLOPE ON EAST SIDE OF PAHRUMP VALLEY, NEV., LOOKING NORTH.



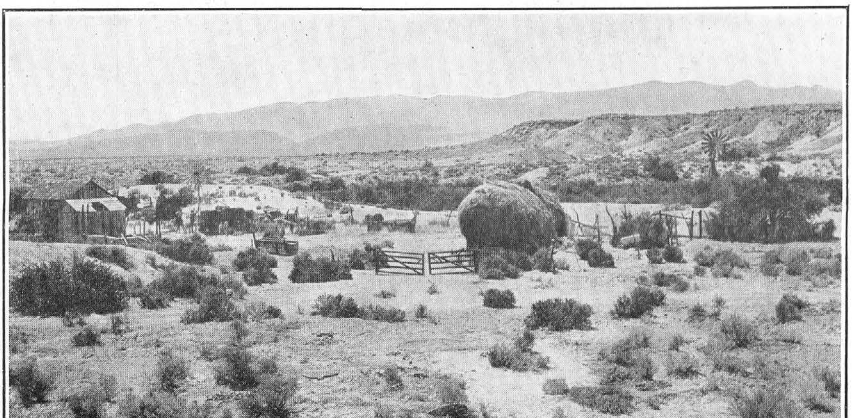
B. STEWART VALLEY, NEV.-CALIF., LOOKING NORTH.



A. SAND RIDGES ON SOUTHEAST SIDE OF MESQUITE LAKE, CALIF., AND ALLUVIAL FANS ALONG EAST BORDER OF MESQUITE VALLEY.



B. CLAY HUMMOCKS IN SOUTHEASTERN PART OF MESQUITE LAKE.



C. CLAY BEDS AND ESCARPMENT AT J. B. YOUNT'S RANCH, PAHRUMP VALLEY, NEV.-CALIF.

Monthly precipitation, in inches, at Pahrump, Nev.

[Elevation 2,608 feet.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1914	......	......	0.14	1.56	Tr.	0.09	......	0.02	0.42	0.05	0	1.01
1915	1.20	1.40	......	......	......	......	......	......	......	......	......	......
1916	......	......	......	......	......	......	0.64	0.42	0	......	0	0.58

The extremes in temperature are great. In the valleys there are usually frosts during November to March, and in the mountains temperatures near zero are common during these months. Snow does not lie on the mountains very long in the spring, however.

VEGETATION.

The higher mountains are sparsely clothed with junipers, which in some portions are sufficiently numerous to form wooded areas. (See Pl. VIII.) The higher part of Spring Mountain also supports yellow pine and piñon, which have been to a large extent cut for lumber for the neighboring mines. The lower parts of the mountains and the extensive alluvial slopes are covered chiefly by creosote bush (*Covillea tridentata*), several species of greasewood (*Sarcobatus*), rabbit brush or rayless golden rod (*Chrysothamnus graveolens*), cactus, and yucca. Sagebrush (*Artemisia tridentata*) was not observed by the writer in any of the basins, but it is found in the elevated valleys east and north of Government Holes, 10 miles southeast of Cima.

In the southwestern part of the Ivanpah basin the giant yucca or Joshua tree (*Yucca* or *Clistoyucca arborescens*) is abundant on the slopes north of Cima, with an undergrowth of creosote bush and greasewood. On the southeast side of the basin the yucca is less common, and it does not descend much below an elevation of 3,000 feet above sea level. In the northern part of the basin, on the slopes of State Line Pass and west of Borax and Jean, a smaller yucca, either a stunted form of the Joshua tree or a related form, is fairly plentiful. The slopes below 2,800 feet are dominated by creosote bush and greasewood down to the flatland bordering the dry lakes. The larger of the two "dry lakes" in Ivanpah Valley is bordered by a zone 200 to 400 yards wide that is occupied by greasewood almost to the exclusion of creosote bush. The smaller lake bed near Roach is bordered by a zone of rabbit brush and stunted greasewood, extending to the base of the alluvial slopes, where the creosote bush becomes dominant. The lake beds themselves are barren of vegetation and during most of the year have hard, level clay surfaces. During storms they may be covered by water to a depth of several inches.

Mesquite Lake is surrounded by a belt of mesquite trees in some places 100 yards or more in width. Sand ridges on the east side of the lake bed (Pl. X, *A*) are also in part covered by mesquite. The lake bed is largely crusted with alkaline deposits that are barren of vegetation, and a part of the east side consists of a barren clay flat, dotted with clay hummocks (Pl. X, *B*), some of which are more than 15 feet high, but in some portions of the lake bed there are sparse growths of salt grass and other alkali-resistant plants.

In the Pahrump basin mesquite grows along the east side of Stewart Valley, and there are groups of the mesquite trees near Sixmile, Mound, Stump, and other springs. On the lower slopes a yucca, smaller than the average Joshua tree but resembling it, is the most prominent plant, though scattered clumps of stunted greasewood and creosote bush form the principal growth. Along the upper borders of the alluvial slopes an occasional barrel cactus is found. The lake bed southwest of Mound Spring is a barren clay flat, but that of Stewart Valley is covered by salt grass.

ANIMAL LIFE.

Wild animals are not plentiful in this region. Occasionally a coyote or a jack rabbit may be seen, and during the evening or early morning a small variety of swift or fox is abroad, hunting for desert rats. These rats and the lizards are the most common forms of wild life. On the higher slopes, especially in the wooded portions of the mountains, a few birds may be found, but the region as a whole does not furnish much food for animal life. The smaller animals are by no means so common in this region as they are farther west, where in some of the recently homesteaded valleys they are so numerous that rabbit-tight fences are almost essential to the production of crops.

MINERAL RESOURCES.

Mining has been carried on in the mountains of the region for many years. Probably the first production came from the Potosi mine, near the north border of the Mesquite basin, where lead was obtained by the Mormons about 1860. Later ores of gold, silver, copper, and lead were discovered; and in 1906 a material that accompanies some of the lead ores and had been considered to be country rock was recognized by a mining engineer to be an ore of zinc.[1]

In 1914 platinum and palladium were recognized in a gold ore from the Boss mine (3 miles northeast of Ripley), which was an old property, originally developed for copper.[2] One result of the mining rush that followed was the establishment of the town of Platina.

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[1] Hill, J. M., The Yellow Pine mining district, Clark County, Nev.: U. S. Geol. Survey Bull. 540, pp. 225–226, 1913.

[2] Knopf, Adolph, A gold-platinum-palladium lode in southern Nevada: U. S. Geol. Survey Bull. 620, pp. 1–2, 1916.

In 1916 ore from mines in the Mesquite basin was being hauled by auto trucks and by teams to Roach, for rail shipment to smelters, and ore from mines near Good Springs was being brought down by the narrow-gage railroad to the main line at Jean. The prevailing high prices of copper, lead, and zinc had caused the reopening of several properties that had been idle for some time.

In the New York Mountains, south of Ivanpah, tungsten minerals (wolframite and ferberite) were discovered in May, 1916, in old copper and gold-silver prospects. When the region was visited in August, 1916, many claims had been staked and several leases had been taken, but a recent drop in the price of tungsten had caused suspension of work. The prospects are on quartz ledges that cut the coarse gray granite country rock. In some places the quartz carries small amounts of blue and green copper carbonates and black manganese oxide. The Garvanza mill, erected about 1910 2 miles southeast of Brant, for the chlorination of the gold ore, was not successfully used, but small amounts of gold and copper ores from the mines were concentrated and shipped.

About 10 or 15 years ago salt was produced in Mesquite Lake by the evaporation, in iron pans heated by mesquite wood, of brine obtained from shallow pits, and the product was taken to San Bernardino and sold. In the pits at the old workings (locality 84, Pl. VIII) crusts of salt form. A sample collected by the writer in August, 1916, was analyzed in the United States Geological Survey laboratory by W. B. Hicks and reported to be nearly pure sodium chloride. It contains small amounts of sulphate, calcium, and magnesium and a trace of potassium.

About half a mile northwest of the old salt works the surface over several acres is strewn with large crystals of gypsum, which develop in the mud and seem to work their way up to the surface, where they disintegrate and cover the ground with shining flakes. It is said that a number of years ago about 1,200 acres on the west side of the dry lake was staked as placer gypsum claims, but in 1916 no assessment work appeared ever to have been done.

GEOLOGIC SKETCH.

STRUCTURE.

The dominant structural feature of the region is the Spring Mountain, a mass of irregular shape which has a general northwesterly trend and culminates in Charleston Peak, on the east side of the Pahrump basin. The range was studied by members of the Wheeler Survey[1] and in 1900–1901 by the late R. B. Howe, whose

[1] U. S. Geol. Surveys W. 100th Mer. Rept., vol. 3, pp. 124, 166, 179, 180, 1875.

notes were incorporated by Spurr [1] in a report on the region. These studies show that the mountains have been uplifted by extensive folding and faulting. Spurr [2] says that the range "shows more complex folding than any of the ranges north or east, and to this folding the irregular shape of the range is probably due. * * * In an east-west section the general structure of the range seems to be a broad syncline, with a number of minor folds of little importance. * * * In a north-south section the structure * * * appears to be anticlinal." Hill [3] visited the south end of the range in 1912 and found that "in this region the general structure seems to be monoclinal, but it is complicated by numerous faults and some folding. * * * The ridges extending westward into Mesquite Valley are faulted in a very complicated manner."

The Kingston and Nopah ranges, which together form the western border of the Pahrump and Mesquite basins, have steep fronts, especially on the west side of the Nopah Range. According to R. B. Rowe [4] the general structure of these ranges seems to be monoclinal, the dip being eastward, but there are many faults. At Kingston Peak the rocks are somewhat folded but have a general northward dip.

No detailed studies of the mountains bordering the southern part of the Ivanpah basin have been made. Clark and Ivanpah mountains, on the west, and the New York Mountains and their northern extensions in the McCullough Range, on the south and southeast, are all believed to be greatly faulted, with minor folding, and to have a complex structure, much like that of Spring Mountain, to which both the eastern and western limiting mountains of Ivanpah basin are structurally related.

CLASSES OF ROCKS.

Granite and gneiss, presumably of Archean age, are found in the southwestern part of the New York Mountains. A belt of granite forms the central part of Clark Mountain,[5] and granite also forms the core of the mass that culminates in Kingston Peak.[4] The greater part of the mountains in the region, however, are composed of ancient sedimentary rocks. Quartzite, considered to be of Cambrian age, overlies the granite of Kingston Peak, and Cambrian lime-

[1] Spurr, J. E., Descriptive geology of Nevada south of the 40th parallel and adjacent portions of California: U. S. Geol. Survey Bull. 208, pp. 164–180, 1903.

[2] Idem, p. 175.

[3] Hill, J. M., The Yellow Pine mining district, Clark County Nev.. U. S. Geol. Survey Bull. 540, p. 233, 1914.

[4] Spurr, J. E., op. cit., p. 199.

[5] U. S. Geog. and Geol. Surveys W. 100th Mer. Rept., vol. 3, p. 32, 1875.

stones and other sedimentary rocks have been mapped by Spurr[1] as constituting the Nopah and adjacent ranges, the ranges near Clark Mountain, the McCullough Range, and the northern part of the New York Mountains. Spring Mountain and its offshoot, the Bird Spring Range, are composed chiefly of massive limestones and conglomerates of Carboniferous age.[2] Small areas of sandstone and shale of Triassic and Jurassic age are present north of Good Springs. No consolidated sedimentary materials of later age than the Jurassic have been recognized in the region, but there are a few small areas of lava, probably of Tertiary age, notably on Table Mountain, between Platina and Jean.

Each of the three valleys is underlain by deep deposits of alluvium. Great alluvial slopes extend from the bases of the mountains down to the lowlands. In their upper portions these slopes consist chiefly of angular gravel and cobbles, but in their lower portions the material is chiefly sand, silt, and clay. The greater part of the lowland in Pahrump Valley is underlain by calcareous sandy soil. In the northern part of Mesquite Valley numerous wells that were dug a few years ago show that the material is almost entirely silt and clay down to the ground-water level. In most of these wells only light-colored, nearly white calcareous clay and silt are exposed; but the northernmost well (No. 52, Pl. VIII) exposes about 50 feet of red-brown calcareous sandy silt, overlying the more common white material.

Along the east side of Pahrump Valley, from Pahrump to a point some distance south of Stump Spring, there are beds of light brown to cream-colored clay from only 2 or 3 feet thick to a maximum thickness, near Stump Spring, of about 50 feet. (See fig. 4.) The clay beds along the north side of the road between Manse and Pahrump contain layers and lenses of limestone gravel and in some places the clay is calcareous and cemented into a very hard material. A test well on the north side of the road halfway between Manse and Pahrump is said to have reached gravel underlying the clay at a depth of 41 feet. The western front of the beds form low but conspicuous bluffs at several places, notably at J. B. Yount's ranch (see Pl. X, *C*), suggesting a fault scarp. At no place were any of the clay beds observed to pass beneath the gravelly alluvium. Where the upper border was seen, east of Stump Spring and also east of Pahrump, the clay immediately overlies the alluvial wash, and its eastern limit is marked by a declivity several feet high. In the vicinity of Yount's ranch, where the formation covers the widest area, its surface rises with a uniform slope of about 100 feet to the mile north-

[1] Spurr, J. E., op. cit., pl. 1.
[2] Hill, J. M., The Yellow Pine mining district, Clark County, Nev.: U. S. Geol. Survey Bull. 540, pl. 4, 1914.

eastward to the lower border of the gravelly alluvial wash. In the southeast the clay extends up to an elevation of about 3,000 feet above sea level; but at its northwest end, near Pahrump, it is only 2,700 feet above sea level. These clay beds were presumably laid down in a lake or playa that formerly occupied that part of Pahrump Valley and were later elevated, probably with tilting and faulting.

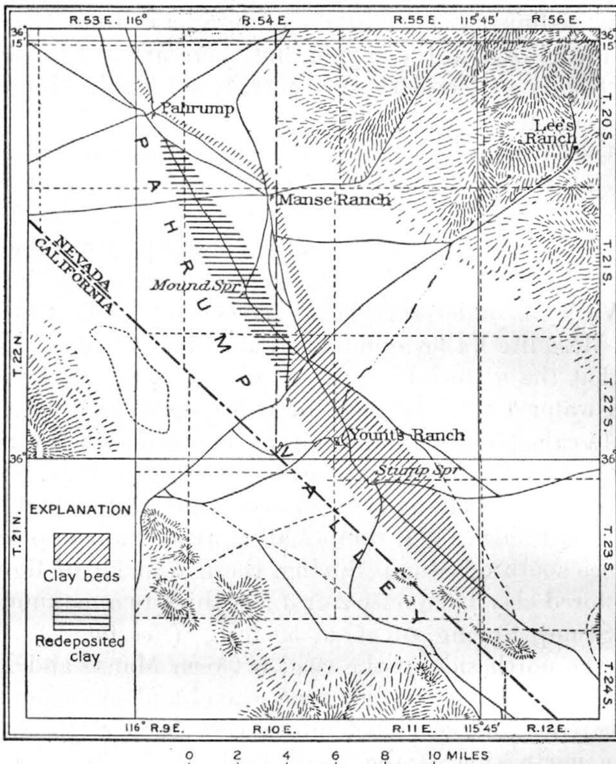


FIGURE 4.—Sketch map showing approximate extent of elevated clay beds in Pahrump Valley, Nev.

Between Mound Spring and Pahrump there is a belt of soft, fine-grained calcareous soil, standing 3 or 4 feet above the mean level of the valley floor, which seems to consist of clay redeposited by storm waters that have brought it from the main bed of clay to the east.

No evidence of clay beds appreciably above the levels of the playas and adjacent low slopes was observed in Mesquite and Ivanpah valleys. The drainage basins of these two valleys are smaller than that of Pahrump Valley, and they are surrounded in general by lower mountains, upon which less rain and snow fall, so that it is improbable that they formerly contained extensive lakes.

GROUND WATER.

PAHRUMP VALLEY.

SPRINGS.

Several large springs and many small ones are found in the mountains on the east side of Pahrump Valley and along the base of the mountains. A few large springs also occur farther down in the valley.

Lee's Spring and Trout Spring, up in the mountains, and Intermittent Spring and the Pahrump Valley springs, at the base of the mountains, yield large flows. The records of flow of these streams, as measured by the United States Geological Survey, are given in the following tables:

Daily discharge, in second-feet,[a] of Lee's Spring near its source, 18 miles east of Pahrump, Nev., for the period Apr. 1 to Sept. 30, 1916.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Day.	Apr.	May	June.	July.	Aug.	Sept.
1	9.0	12	4.9	2.4	1.5	0.9	16	10	7.1	3.8	3.7	1.2	0.7
2	8.9	11	4.7	2.4	1.7	.9	17	12	6.6	3.7	2.9	1.1	.7
3	9.7	12	4.7	2.3	1.6	.9	18	12	6.2	3.5	2.6	1.1	.6
4	8.0	14	4.7	2.3	1.5	.9	19	12	6.4	3.5	2.3	1.0	.6
5	7.3	15	4.5	2.2	1.5	.9	20	12	6.0	3.2	2.0	1.0	.6
6	6.8	13	4.5	2.2	1.4	.8	21	13	6.0	3.0	1.9	1.0	.6
7	6.8	12	4.5	1.7	1.4	.8	22	14	6.2	2.7	1.9	1.0	.6
8	8.0	12	4.4	1.6	1.4	.8	23	16	6.2	2.7	1.9	1.0	.6
9	9.9	11	4.4	1.6	1.4	.8	24	18	5.8	2.8	1.7	1.0	.6
10	12	10	4.4	1.6	1.3	.8	25	18	5.5	2.8	1.6	1.0	.6
11	11	9.6	4.4	1.6	1.3	.7	26	20	5.1	2.7	1.6	1.0	.5
12	8.9	9.2	4.2	1.6	1.3	.7	27	20	5.3	2.6	1.6	1.0	.5
13	7.8	8.4	4.0	1.6	1.3	.7	28	20	5.3	2.4	1.5	1.0	.5
14	7.3	8.0	4.0	2.0	1.2	.7	29	19	5.3	2.4	1.5	.9	.5
15	8.4	7.5	4.0	12	1.2	.7	30	16	5.3	2.4	1.5	.9	.5
							31	......	5.1	......	1.5	.9	......

[a] A second-foot is equal to about 448 gallons per minute.

Monthly discharge of Lee's Spring near its source, 18 miles east of Pahrump, Nev., for the period Apr. 1 to Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
April	20	6.8	12.0	714
May	15	5.1	8.32	512
June	4.9	2.4	3.68	219
July	12	1.5	2.28	140
August	1.7	.9	1.20	74
September	.9	.5	.69	41
The period	....	....	....	1,700

Discharge measurements of Trout Creek about 5 miles below Trout Spring, or 16 miles east of Pahrump, Nev.

[Made by Albert Quill.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1916.	*Feet.*	*Sec.-ft.*	1916.	*Feet.*	*Sec.-ft.*	1916.	*Feet.*	*Sec.-ft.*
Apr. 6	0.60	1.75	June 15	0.40	1.70	Aug. 17	0.32	1.22
20	.65	2.16	22	.40	1.70	24	.32	1.22
27	.70	2.69	30	.35	1.39	31	.33	1.28
May 8	.44	1.96	July 6	.34	1.33	Sept. 7	.31	1.16
11	.45	2.03	13	.34	1.33	14	.29	1.05
17	.45	2.03	20	.33	1.28	21	.28	1.00
24	.43	1.90	27	.33	1.28	28	.27	.94
June 1	.43	1.90	Aug. 3	.33	1.28	Oct. 5	.28	1.00
8	.42	1.83	10	.33	1.28			

Daily discharge, in second-feet, of Intermittent Spring 50 yards below its head, 16 miles east of Pahrump, Nev., for the period Apr. 1 to Sept. 30, 1916.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Day.	Apr.	May.	June.	July.	Aug.	Sept.
1	23	36	16	9.4	5.0	2.2	16	20	24	17	13	4.0	1.2
2	22	33	16	9.1	5.7	2.2	17	23	23	16	10	3.7	1.1
3	22	32	16	8.6	5.7	2.0	18	24	22	16	9.1	3.5	1.1
4	21	33	16	8.1	5.2	2.0	19	24	22	15	8.3	3.3	1.0
5	20	34	16	7.8	5.0	1.9	20	24	21	14	7.8	3.1	.9
6	18	35	17	7.8	5.0	1.8	21	25	20	14	7.6	3.0	.8
7	18	34	17	7.3	4.8	1.6	22	26	19	13	7.3	3.0	.8
8	18	33	18	7.1	4.8	1.5	23	28	19	12	6.6	3.0	.8
9	19	33	18	6.8	4.8	1.5	24	31	19	12	6.4	2.8	.6
10	22	33	18	6.4	4.6	1.4	25	32	18	12	6.4	2.6	.6
11	24	33	18	6.4	4.6	1.4	26	33	17	11	6.2	2.4	6
12	22	33	18	6.2	4.4	1.3	27	36	16	11	5.9	2.5	.5
13	21	31	17	5.9	4.2	1.3	28	38	16	10	5.7	2.6	.5
14	20	29	17	5.9	4.2	1.3	29	39	16	9.9	5.2	2.5	.4
15	20	26	17	15	4.0	1.3	30	38	16	9.6	5.0	2.4	.4
							31	......	16	......	5.0	2.2	......

Monthly discharge of Intermittent Spring 50 yards below its head, 16 miles east of Pahrump, Nev., for the period Apr. 1 to Sept. 30, 1916.

Month.	Discharge in second-feet.			Run-off in acre-feet.
	Maximum.	Minimum.	Mean.	
April	39	18	25.0	1,490
May	36	16	25.5	1,570
June	18	9.6	14.9	887
July	15	5.0	7.53	463
August	5.7	2.2	3.83	236
September	2.2	.4	1.20	71
The period	....	....	....	4,720

Measurements of Pahrump Valley Creek (fed by the Pahrump Valley Springs) 15 miles southeast of Pahrump, Nev.

[Made by Albert Quill.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1916.	*Feet.*	*Sec.-ft.*	1916.	*Feet.*	*Sec.-ft.*	1916.	*Feet.*	*Sec.-ft.*
May 13	1.90	22.3	July 6	1.46	10.4	Aug. 24	1.14	4.53
18	1.90	22.4	13	1.40	9.19	31	1.06	3.36
24	1.86	21.6	20	1.44	9.61	Sept. 7	1.02	2.99
31	1.81	19.4	27	1.38	8.48	14	1.00	2.45
June 8	1.76	17.7	Aug. 3	1.36	8.25	21	....	1.91
15	1.71	16.6	10	1.22	5.73	28	.94	1.33
22	1.62	14.0	17	1.18	4.93	Oct. 5	....	.61
29	....	11.7						

Intermittent Spring issues in full volume in a bouldery wash. As is shown by the discharge record, although the flow is large in the spring months, it lessens until the stream becomes nearly dry in the later part of the summer. Pahrump Valley creek heads in a large spring (No. 37), and another spring, which had a flow of about 0.6 second-foot in August, 1916, joins the creek a few hundred yards below. These large springs, as well as the smaller ones, derive their water directly from the precipitation on the slopes above them, and consequently their flow decreases from a maximum in the spring months of rain and of melting snow to a minimum at the end of the dry season.

Horseshutem Spring (No. 2, Pl. VIII), near the north edge of the basin, has been estimated to yield 200 barrels a day. Its water has been piped down to the mining camp of Johnnie for domestic use.

Stump Spring (No. 49) is in a gully in the clay beds along the east side of the valley and apparently derives its water by seepage from these beds or from the gravel immediately underlying them. Its normal flow has been estimated at 20 barrels a day.

Large springs are found at the Pahrump and Manse ranches, and the water at each place has been used for many years for irrigation. At Manse there are two springs 75 yards apart. The temperature of the water in each is 75° F. The flow of the smaller spring is about 0.8 second-foot and the combined flow of the two springs, measured September 30, 1916, by Albert Quill, of the United States Geological Survey, was 3.23 second-feet.

At the Pahrump ranch there is a group of two large springs and one smaller one that are similar to those at Manse. The water rises principally in a pool 20 or 30 feet in diameter and 3 or 4 feet deep bordered by banks of partly cemented gravel a few feet high. The sandy bottom of the pool is kept in ebullition by the rising water, which has a temperature of 76½° F. The flow of the two larger springs, as measured by Albert Quill September 30, 1916, was 2.53 and 2.20 second-feet.

On J. M. Raycraft's ranch, half a mile northwest of Pahrump, there is a spring (near well location No. 12), which is probably similar in character to the large ones at Pahrump and Manse. It rises in a small marshy area and flows about 10 gallons a minute. A few hundred yards southeast of this spring there is a mass of calcareous tufa, apparently a spring deposit, forming a low mound 10 or 15 yards in diameter.

Mound Spring, 4 miles south of Manse, formerly had a small flow. It is at the base of a low mound composed of clay and fine sand. This mound was probably built, like many similar ones at desert springs, by the moistening and retention of material blown by the wind to the spring. The small spring at Mr. Raycraft's ranch issues at the base of a similar mound, and it is reported that there are also small springs at other mounds near by.

The springs along the border of the lowland seem to be supplied by water which rises from a considerable depth under artesian head produced in the extensive alluvial deposits to the east or possibly from deeper sources. The general character of the alluvial slope and the positions of the Manse and Pahrump ranches with respect to them are shown in Plate IX, *A*, a view looking northward along the east side of the valley. Evidence that the water comes from a deep source is furnished by the temperature of the springs—75° F. at Manse and 76½° F. at Pahrump, as compared with that of Intermittent Spring—57° F. The uniform flow of the Pahrump and Manse springs, contrasted with the varying flow of Intermittent Spring and the other mountain springs, also indicates that the mountain springs and the valley springs are supplied in different ways.

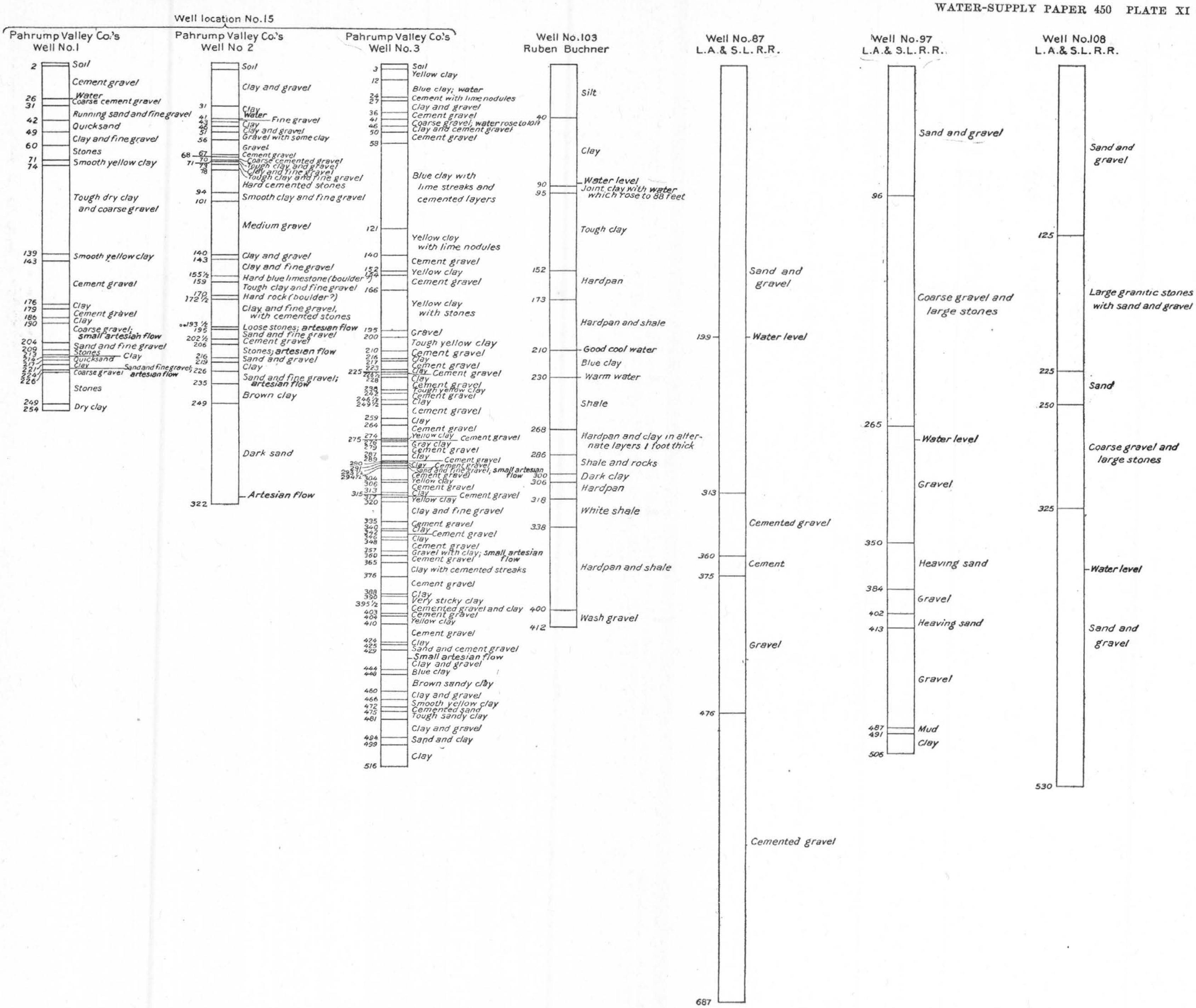
ARTESIAN WATER.

Besides the springs in Pahrump Valley that seem to give evidence of artesian conditions, there are several wells that yield artesian flows. (See table below.) Three wells on the Pahrump ranch have been drilled 200 or 300 yards apart, and the easternmost is 225 yards west of the main spring at this ranch. The records of these wells, presented through the courtesy of Mr. T. G. Darrough, manager of the ranch, are shown graphically in the left-hand portion of Plate XI. The artesian flows seem to have been obtained at several horizons below a depth of 200 feet, from layers of sand or gravel beneath relatively impervious beds of clay or cement gravel. The wells have the following flows, according to measurements with current meter made September 30, 1916, by Albert Quill, of the United States Geological Survey:

Flows of artesian wells on Pahrump ranch.

Well No.	Flow.		Temperature (°F.).
	Second-feet.	Gallons per minute.	
1	1.25	560	78½
2	.64	287	75
3	.62	278	74

J. M. Raycraft has three flowing wells, each 10 inches in diameter and about 175 feet deep, at his home (locality No. 12, Pl. VIII) on a low mound of wind-blown sand half a mile northwest of Pahrump. The wells flow about 35, 35, and 260 gallons a minute



SECTIONS OF WELLS IN PAHRUMP AND IVANPAH VALLEYS, NEV.-CALIF.

(according to measurements by the writer), and the water from each well has a temperature of 79° F. A quarter of a mile to the southeast a fourth well (No. 13) encountered flowing water at a depth of 285 feet; the discharge as measured by the writer was about 65 gallons a minute and the temperature 79° F. The following partial record of materials encountered in drilling this well was kindly furnished by Mr. Raycraft:

Record of J. M. Raycraft well (No. 13), Pahrump, Nev.

	Thickness.	Depth.
	Feet.	*Feet.*
Unrecorded	82	82
Hard limestone	3	85
Clay	5	90
Coarse cement gravel	3	93
Clay	43	136
Cement gravel	3	139
Unrecorded	147	286
Hard blue limestone (bedrock)	36	322

A fifth flowing well (No. 16), belonging to Mr. Raycraft, is said to have a somewhat larger flow than well No. 13.

F. A. Buol has also obtained flows near his house (at well locality No. 11) in five wells reported to be 150 to 520 feet deep, but detailed information concerning these wells was not obtained.

In the vicinity of Mound Spring several test wells were drilled during 1914–1916 by the Oasis Land Co. Water under artesian pressure was encountered in all of them, and in two (Nos. 32 and 33) small flows were obtained. Well No. 32 was sunk to a depth of 135 feet a few yards from Mound Spring, and in August, 1916, the water rose 15 feet above the surface. In well No. 33 flows were struck at depths of about 200 and 390 feet but were lost in gravel at 535 feet. After the well was filled to about 475 feet below the surface a slight flow was again developed. In August, 1916, the flow was about 1 gallon a minute, with a temperature of 72° F. It is said that in the Spanker wells (Nos. 40 and 41), 3 miles southwest of Mound Spring, water from the lower strata did not rise higher than 65 feet below the surface, and that the first water, struck at 23 feet, flowed down the well to the 65-foot level. J. B. Yount has sunk a well (No. 44) on his ranch, 7 miles southeast of Mound Spring, to a depth of 320 feet. A flow was not obtained, but at 225 feet water was struck in fine sand beneath clay under pressure that caused it to rise within 6 feet of the surface.

The great alluvial slopes that extend east and southeast of Yount's ranch probably contain water under considerable artesian head, and the lower portions of these slopes offer favorable conditions for obtaining artesian flow. It is possible that flows can also be developed in the lower part of Pahrump Valley, but the fact that the artesian springs and the artesian wells drilled up to August, 1916, are all more than 2,650 feet above sea level suggests that the artesian water may be shut off from the strata beneath the lower lands by the fine and relatively impervious sediments deposited in the lowest part of the valley.

WATER TABLE.

In Stewart Valley, which forms the lowest part of the Pahrump drainage basin, water is present at less than 10 feet beneath the surface and has caused the growth of salt grass. The water table around its borders fluctuates somewhat with the season and is highest in the spring, when the valley receives some surface water. The seasonal change is sufficient, so that shallow wells at localities 8 and 9 (Pl. VIII), which have at times served as watering places, were dry in August, 1916. At the south end of the valley, in well No. 25, dug close to the drainage channel leading to the central depression, the water stood 38 feet below the surface. Farther up the same drainage course water stood about 6 feet below the surface at Sixmile Spring in a pit in a low sandy mound. In the flowing wells drilled at and near Pahrump water was struck at 20 to 30 feet below the surface. In well No. 26, about 4 miles south of Pahrump, water was struck at 32 feet, and in wells Nos. 28, 40, and 41, 4 to 6 miles farther south, at 23 feet. In several wells near Mound Spring water was struck at 28 to 39 feet. The water, therefore, seems to be within 40 feet of the surface throughout a large part of Pahrump Valley. The quantity of ground water recoverable from shallow wells appears to be rather small, however, as the water is obtained in fine sand and silt that do not readily furnish a pumping supply.

A well dug about 5 miles southeast of Mound Spring is said to have struck water at a depth of 97 feet. No other information concerning the depth to water beneath the higher slopes was obtained. The reported depth in this single well, however, indicates that on the east side of the valley the water table slopes upward at a gradient that makes the increase in depth to water about 25 feet with each 100 feet of rise in the elevation of the surface.

The data obtained in regard to wells in this valley are tabulated on pages 76–79.

QUALITY OF WATER.

Samples of water for analysis were collected in the Pahrump basin from two springs (Nos. 22, 29, Pl. VIII), one flowing well (No. 15, 254-foot well on Pahrump ranch), and two shallow wells (Nos. 25, 45). (See table, p. 80.) The waters are on the whole better than those from the Mesquite or Ivanpah basins, the highest total solids being only 537 parts per million. The waters from the two springs are the best. Although the conditions governing the occurrence of these two springs are apparently different, the waters are of approximately the same mineralization, differing in total solids by only 17 parts per million, and both are of the same character. No. 22 contains only 4.3 parts per million of sodium and potassium, and No. 29 contains only a trace of these elements. The samples from wells Nos. 15 and 45 are similar to the spring waters in that they are calcium-carbonate in character, but they contain somewhat more mineral matter. The most highly mineralized water analyzed from the Pahrump basin (from the Buchanan well, No. 25) contains 537 parts per million of total solids and is of the sodium-carbonate type. The greater mineralization and high sodium content of this water are probably due to the location of the well, which is in almost the lowest part of the basin, close to a channel that carries the drainage from a playa south of Sixmile Spring into the lowest part of Stewart Valley.

All the waters are of fair quality for domestic use. They can be used without difficulty for cooking and drinking but are somewhat unsatisfactory for washing on account of their rather high hardness. All the waters except that from the Buchanan well (No. 25) are classed as fair for boiler use, although the scale-forming constituents are in excess of the amounts ordinarily considered to be allowable in a fair water, according to the rating in the table on page 80. Such a classification was made because the amounts of foaming constituents are so far within the limits for a good water. The waters could be improved by proper chemical treatment for the reduction of the scale-forming constituents. The water from the Buchanan well is of poor quality for boiler use because, in addition to the large amount of scale-forming constituents, the foaming ingredients are also high. All the waters except that from the Buchanan well are good for irrigation, and even that water can be used with good results if proper care is observed. This well is used very seldom, and it is possible that the quality of the water might be improved by regular pumping.

From the analyses it seems probable that waters fair for domestic and boiler use and good for irrigation can be obtained throughout most of Pahrump Valley. In the lowest parts of the valley, especially near the playas, there may be some highly mineralized waters.

IRRIGATION.

Within recent years farming has been attempted in each of the three valleys under consideration, but success has been obtained only where irrigation is practiced. Experiments have fully demonstrated that the rainfall is too slight and uncertain and the dry periods are too long and hot to allow the successful growing of crops by dry farming.

In Pahrump Valley farming has been carried on for many years at the Manse and Pahrump ranches by irrigation from the large springs at these places. In 1916 about 300 acres on the Manse ranch was under cultivation, 80 acres in alfalfa, 10 acres in vineyard and mixed orchard, and most of the remainder in grain. On the Pahrump ranch, by means of the spring water and that from three flowing wells, about 10 acres of orchard, 90 acres of alfalfa, and 125 acres of barley were irrigated, and in 1916 a considerable acreage of new land was being cleared and leveled, preparatory to planting to alfalfa. Northwest of the Pahrump ranch J. M. Raycraft and F. A. Buol had under cultivation lands that were irrigated by flowing wells. At Lee's ranch, in Trout Canyon, a few acres of alfalfa and vegetables were irrigated by the mountain stream, and at Yount's ranch a garden was supplied with water by windmills pumping from shallow wells. An attempt at farming in Stewart Valley had failed, probably because of the alkalinity of the soil as much as because of the lack of an irrigation supply. The Oasis Land Co. was preparing to develop a Carey Act project involving several thousand acres in the neighborhood of Mound Spring by irrigation water from Lee's Spring and Intermittent Spring, augmented by wells. The lands in the lowest part of the valley, from the "dry lake" west of Yount's ranch to Stewart Valley, are too poorly drained and too liable to become alkaline to be suitable for farming. The lower slopes along the east side of the valley, however, are probably capable of successful cultivation at those places where ground water can be developed for irrigation either in flowing wells or in wells with low pumping lift. The ground water obtained in the valley is generally of suitable quality for agriculture except in the lowest parts, near the "dry lakes."

MESQUITE VALLEY.

SPRINGS.

The only springs reported in the Mesquite drainage basin are Keystone Spring, near the northeast border, and a spring near the Potosi mine, in the north corner of the basin. Neither was visited by the writer, but J. E. Blackburn, who mapped the region in 1909–10, estimated their flow as, respectively, about 15 and 40 barrels a day. The spring near the Potosi mine has since been developed, so that in 1916 it supplied considerable water for the mining settlement.

WATER TABLE.

The depth to water in tne central part of Mesquite Valley was tested in 1910–1914 by a number of wells drilled or dug by entrymen on desert and homestead claims. The locations of the wells that were observed are shown on Plate VIII, and data as to their depth and the depth to water in them are tabulated on pages 76–79. In August, 1916, the depth to water in these wells ranged from 4 feet in pits in Mesquite Lake to 52 feet in Bullock's well, at the southeast border of the lowland; 52 feet at Sandy, in the northeast; and 67 feet in well No. 54, in the northwest. Well No. 51, drilled prior to 1910 in the northern part of the valley to furnish a water supply near the old traction road, extending from the borax deposits near Death Valley to the railroad, was dry at a total depth of 82 feet; but it is said to have formerly contained water at a depth of about 90 feet. The water table beneath the central and northern parts of the valley, along its axis, therefore seems to be fairly flat, as shown in figure 5, with a slope of only 5 or 6 feet to the mile. From northeast to southwest, across the valley, the slope of the

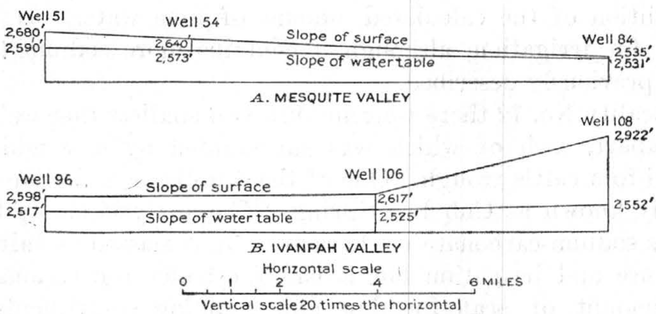


FIGURE 5.—Diagram showing slopes of surface and of water table in Mesquite and Ivanpah valleys, Calif. The Mesquite Valley section extends from northwest to southeast between wells 51 and 84 of Plate VIII; the Ivanpah Valley section extends from north-northwest to south-southeast between wells 96 and 108.

water table is somewhat greater, the available records of surface elevation and of depth to water indicating a rise of the water table toward the northwest of 10 or 12 feet to the mile.

QUALITY OF WATER.

Samples of water from six wells in Mesquite Valley (Nos. 58, 64, 72, 74, 76, and 86, Pl. VIII) were analyzed. (See table opposite p. 80.) All these waters are or have been used for domestic supply, although three of them contain more than 600 parts per million of solids in solution and have a distinctly mineralized taste. Only two of the six waters are better than the most highly mineralized water in the Pahrump basin. The character of the water apparently varies much more from place to place in Mesquite Valley than in Pahrump Valley.

The water from well No. 58, which is the least mineralized of those sampled in Mesquite Valley, is magnesium-carbonate in character. The waters from the Cryor well (No. 76) and the old Sandy

Mill well (No. 74) are like that from No. 58, in that they are carbonate waters, but in them calcium predominates over the magnesium. The Sandy Mill water, however, is more highly mineralized than the other two. These three waters are all classed as good for irrigation. They are so hard that they may be unsatisfactory for cooking and washing, but for drinking and other ordinary household purposes they are probably quite satisfactory. The waters from wells Nos. 58 and 76 are classed as only fair for boiler use because of the amount of scale-forming constituents present, and No. 74 is classed as poor because of its higher content of scale-forming constituents.

The water from the W. A. Tritt well (No. 64) is magnesium-sulphate in character. It is poor for domestic use because of its excessive hardness and bad for boiler use because of its tendency to corrode boilers—a condition, however, which could be corrected by the addition of the calculated amount of lime water. It is satisfactory for irrigation, although it contains more sodium than the waters previously described.

At locality No. 72 there were in 1916 two shallow dug wells a few yards apart, each of which was surmounted by a windmill that pumped to a cattle trough. One of these wells or a similar one was formerly known as Cub Lee Spring. The analysis shows that the water is sodium-carbonate in character. It is classed as fair for domestic use and irrigation but is bad for boiler use because of the large amount of scale-forming and foaming constituents. This water contains a greater amount of chloride than any of the waters described above. The water is probably contaminated to some extent by seepage from the mud trampled by cattle around the troughs, and the chloride content may for this reason be higher than is normal in ground water of this vicinity. An even higher chloride content, however, is found in Bullock's well (No. 86), sometimes known as Knight's well. This well was dug a number of years ago at the base of the desert wash slopes, at the southeast edge of the lowland. It has long furnished water for mines in the mountains to the northeast and for teams and autotrucks hauling ore to the railroad at Roach. The water is distinctly salty in taste, and the analysis shows that of its total content of 1,445 parts of mineral matter, 551 parts, or more than one-third, consists of the chloride radicle. The principal basic radicle is sodium. Although the water is of poor quality it is freely used for drinking and cooking because of the lack of a better supply. It is very bad for boiler use because of the high amount of foaming constituents. It is also poor for irrigation.

The two wells which have the highest chloride content are in the south end of the valley, not far from the salt-incrusted playa known as Mesquite Lake, suggesting that the ground water has become concentrated in this part of the valley by continual evaporation. On the other hand, the least mineralized waters in the basin, according to the analyses, are at the north end and on the sides of the valley some distance from Mesquite Lake.

IRRIGATION.

In 1910 to 1914 numerous homestead and desert entries were filed on land in the northern part of Mesquite Valley, and a number of wells were drilled and pumping plants established. Attempts to irrigate on an extensive scale proved unsuccessful, however, owing largely to the poor quality of the soil. In 1916 there were only two small irrigated tracts in the valley, those of W. A. Tritt and J. B. Cryor. At the Tritt ranch (locality No. 64, Pl. VIII) water was pumped from a dug well by a windmill and used to irrigate a small garden with indifferent success. As is shown by the analysis (opposite p. 80), the water is of good quality for irrigation. Any failure to produce crops was therefore due to the nature of the soil or other causes, rather than to the water. On the Cryor ranch, at Ripley, a few acres of alfalfa and garden were supplied by windmill, and the crops made a good growth under careful irrigation. The water here also is of good quality, as shown by the analysis of well No. 76. It is probable that other areas could be successfully irrigated along the eastern sandy slopes of the valley. The greater part of the shallow-water area in Mesquite Valley, however, is probably too alkaline or too clayey to permit its successful cultivation.

IVANPAH VALLEY.

WELLS, SPRINGS, AND INFILTRATION TUNNELS.

In the mountains that border the Ivanpah Valley there are a number of small but perennial springs that furnish reliable water supplies to prospectors and others. About 20 of these springs are shown on Plate VIII, and data furnished by S. G. Lunde, topographer, of the United States Geological Survey, concerning their yields, have been inserted in the records on pages 76–79. None of these springs yield much water, and some of them have no appreciable overflow during the dry months. Mescal Spring (No. 94) is said, however, to have furnished water for a small stamp mill at the Mollusk mine.

A small spring (No. 114) in the bed of a canyon has furnished water for prospectors in its immediate vicinity, and in 1916 water was also piped from it to the home of P. S. Banfield, three-quarters of a mile east of Brant, for domestic supply.

"Cut Spring" and "White Rock Spring" (Nos. 111 and 112) are small infiltration tunnels driven into the mountain side, and the seeping water collects in pools, from which it is hauled to Cima for domestic supply. At Kessler Spring (No. 113) water has been developed by a pit excavated about 10 feet deep in a dry wash and curbed and roofed with boards. From the bottom of the pit a pipe extends down the wash for several rods, so that a gravity flow is obtained at cattle troughs and at a faucet for domestic and travelers' supplies. Water supplies have been obtained at other places in washes at high levels in shallow wells like that of Kessler Spring, but so far as was learned gravity flows have not been developed elsewhere in this region by piping. The Mexican well (No. 93) is reported to be only 5 feet deep and usually to contain about 3 feet of water. When visited by D. G. Thompson late in 1917 it was tightly covered and equipped with a force pump. Water was hauled from the well to the Mohawk mining camp, 4½ miles west of the well, and was also used in considerable quantities by teams hauling ore from this camp to Roach. The supply is apparently very good. Water has been developed by somewhat deeper wells dug in the gravelly wash at Crescent (No. 104). The mining camp of Good Springs (No. 63) received its name from springs that formerly flowed in considerable volume, but it is said that of late years water is obtained chiefly from wells about 30 feet deep, dug in the gravel wash.

At Borax siding, 4 miles south of Jean, a well (No. 87, Pl. VIII) was drilled in 1905 by the Los Angeles & Salt Lake Railroad Co. to a depth of 687 feet. The record, kindly furnished by the company and reproduced graphically in Plate XI (p. 64), shows that only relatively coarse, unconsolidated materials were encountered. Water stood in the well 199 feet below the surface in 1905. The pumping station was dismantled in 1914, as the pumping station near Ivanpah served the railroad needs.

At Roach a test well, drilled by George Morgan, struck water at 91 feet. The water is said to be of fair quality, but the settlement is supplied with water brought by train from Las Vegas, as is also the town of Jean.

An abandoned dug well (No. 89) 2½ miles southwest of Roach and the Francis well (No. 102), dug more than 20 years ago on the west side of Ivanpah Valley, near the traction road, both contained water in August, 1916, at a depth of 90 feet below the surface.

The Yates well (No. 96) and the Murphy well (No. 106) were dug a number of years ago for cattle watering places. They are situated, respectively, at the west edge of Ivanpah Lake and at the south edge of the flat land bordering the "dry lake." They were abandoned some time prior to 1916, but the Murphy well was again used in 1917 for watering cattle. In August, 1916, the Yates well contained water at 81 feet and the Murphy well at 92 feet. Several wells drilled in 1914–1916 between the Murphy and Yates wells encountered water at practically the same level as in these wells. On the extensive alluvial slope in the southern part of the Ivanpah basin a well of the Los Angeles & Salt Lake Railroad supplies water to a reservoir near Ivanpah, for locomotive use. The reported depth to water in this well—370 feet—indicates that the water table beneath the valley is unusually flat, as is illustrated in figure 5 (p. 69). The rise of the water table southward from the Murphy well to the railroad well is only 5 feet to the mile, whereas the rise in elevation of the surface is 61 feet to the mile. From east to west across the valley the water table also seems to be nearly horizontal; for at Lyon station, 2,800 feet above sea level, the depth to water is reported to be 275 feet, the elevation of the water table therefore being 2,525 feet, or only 8 feet above the elevation of the water surface in the Yates well. The flatness of the water table indicates that the desert wash is fairly coarse and permeable throughout, so that water does not collect in porous sands and gravels between layers of relatively impermeable clay. In the wells that have been drilled, it is reported, water was encountered under little or no artesian pressure.

In many of the basins of the Southwest that have no outlets for surface water the supply of ground water received from precipitation is about balanced by losses through springs and evaporation from lakes or from the soil where the water is close to the surface. This condition is present in Pahrump and Mesquite valleys, where moist lands are found respectively in Stewart Valley and in Mesquite Lake. Beneath the lowest portions of Ivanpah Valley, however, the depth to water is about 80 feet, and it seems impossible that evaporation keeps the water table down to so great a depth below the surface. The water table from east to west across the valley is shown by the depth to water in wells Nos. 96 and 97 to be nearly horizontal. Toward the south the water table (see fig. 5) slopes gently upward. The elevation above sea level of the water table in Ivanpah Valley is about 2,515 feet and in Mesquite Lake about 2,531 feet, so that there would seem to be no underground escape northward. It is possible that leakage sufficient to balance the relatively small annual ground-water intake and keep the water table down to about 80 feet below the surface takes place along fault fractures extending northeastward toward Las Vegas Valley.

QUALITY OF WATER.

Samples of water from two springs (Nos. 111 and 113, Pl. VIII) and six wells (Nos. 89, 93, 96, 103, 106, and 108) in the Ivanpah basin were analyzed. (See table opposite p. 80.) One analysis furnished by the Los Angeles & Salt Lake Railroad (well No. 97) has been included in the table. The analyses show great extremes in the degree of mineralization of the waters in the valley, one sample (No. 108), which is the best water analyzed from the three valleys described in this report, having only 240 parts per million of total dissolved solids. Another water (No. 89) contains more than 100 times as much. Four of the nine waters are of good or fair quality for domestic, boiler, and irrigation use.

The waters from three wells in the southern part of the basin (Nos. 103, 106, and 108) are relatively low in total solids. Of these the water from the railroad well (No. 108) on the alluvial slope some distance above Ivanpah Lake contains only 240 parts per million, and the waters from the other two wells, which are much nearer the clay flat, are higher in total solids, containing 372 and 335 parts. The water from the railroad well is a sodium-sulphate water and the other two are sodium-carbonate waters. All three waters are classed as good for domestic use. The water from the railroad well, which is regularly used for locomotives, is classed as good for boilers. The other two are classed as only fair for boiler use on account of their content of foaming constituents. The water from the Murphy well (No. 106) will also form considerable scale. The waters from the railroad and Murphy wells are good for irrigation, but that from well No. 103 is only fair.

According to analyses of samples from wells Nos. 89 and 96, the water farther north, in the lowest part of the valley, is much poorer; in fact, it is practically unfit for any use. These wells are dug only a few feet below the ground-water level. It is said that they furnished water of fair quality when they were used regularly. They had been abandoned for some time prior to August, 1916, and at that time contained waters that were practically brines, one (No. 96) containing 7,702 parts per million of total solids and the other (No. 89) containing the unusually high amount of 27,501 parts per million. Both waters taste salty. It is said that in digging the Yates well (No. 96) salty water was first struck, but better water was obtained a few feet deeper. It is probable that in each well the water has become concentrated on standing unused. Both waters are sodium-chloride in character, and both are unfit for domestic, boiler, or irrigation use. A water from a well drilled by the Los Angeles & Salt Lake Railroad Co. at Lyons (Desert station) (No. 97), almost due east of Yates, according to an analysis furnished by the railroad company, is of much better quality, containing only 433 parts per million of total solids. It is sodium-chloride in character. This well is some distance up the alluvial slope away from the clay flat. The water is classed as good for domestic purposes, bad for boiler use, and fair for irrigation.

The remaining sources from which samples were analyzed, Nos. 93, 111, and 113, are all in the mountainous parts of the Ivanpah basin. Each of the three waters is a carbonate water. Two of them, from Cut Spring (No. 111) and Kessler Spring (No. 113), are calcium-carbonate waters. They are both classed as only fair for domestic use because of their hardness; they will probably require a considerable amount of soap in washing, but are good for drinking and other household purposes. The water from Cut Spring is hauled to Cima for domestic use. The waters from both Cut Spring and Kessler Spring are good for irrigation.

The water from Mexican well (No. 93) is sodium-carbonate in character and is considerably higher in total solids than the other two. It is good for irrigation but poor for boiler use because of its large amount of scale-forming and foaming constituents and poor for washing because of its high hardness. This water is used considerably by travelers, and despite its hardness it can probably be used for drinking and other ordinary household uses without any bad effects.

Although analysis shows two waters from the Ivanpah basin to be very highly mineralized, it is believed that throughout the greater part of the region water of good or fair quality for both domestic purposes and irrigation is available. The two saline waters were obtained from wells in the lowest part of the basin, at the edge of the playa. The high mineralization of these waters may be due to concentrated surface waters running into the wells or to salt derived from the clay of the playa. The water from wells on the alluvial slopes, some distance from the clay flat, is generally of good quality.

IRRIGATION.

During the three years prior to 1916 several wells were drilled in the lowlands south of Ivanpah Lake and a few attempts at irrigation were made, but these attempts proved unsuccessful on account of the clayey character of the soil. On the higher land, near Cima and Brant, gardens have been grown with water from springs, but the available supply from such sources is insignificant. Farming other than the cultivation of small gardens probably can not be successfully carried on in any part of Ivanpah Valley because of the lack of available water. Irrigation by means of wells is not feasible, because of the excessive pumping lift involved, and because water is not found in great enough quantity. In January, 1918, it was stated that the Murphy well (No. 106) could be pumped dry in about four hours at a rate of about 20 gallons a minute. This amount of water was derived from a 12-foot tunnel at the bottom of the well, which is in adobe. The water does not filter in rapidly enough to meet the ordinary requirements of irrigation. The soil in the lowest part of the valley, where the pumping lift is the least, is too clayey and too alkaline for successful cultivation. There is no stream water available, and apparently no suitable locations for storage reservoirs nor sufficient flood water to be of value if it could be stored.

In the later part of 1917 and the early part of 1918 no one was attempting farming in the Ivanpah Valley, and the valley had been practically abandoned as an agricultural project. The Rock Springs Cattle Co. had improved the Murphy well (No. 106) and was using it to water about 200 head of cattle. The number of cattle that may be kept in the valley is largely limited by the available supply of wild grass, as the conditions of water supply and soil will not permit the cultivation of grazing crops.

RECORDS OF WELLS AND SPRINGS.

Most of the wells and springs listed in the following pages have been mentioned in the text. The available data concerning all those whose locations are shown on Plate VIII are here brought together in tabular form for easy reference in connection with the map.

Records of wells and springs in Pahrump, Mesquite, and Ivanpah valleys, Nev.-Calif.

[For analyses of water see table opposite p. 80.]

No. on Plate VIII.	Location.[a]			Owner of well or name of spring.	Depth of well.	Depth to water in well August, 1916.	Remarks.
	Township.	Range.	Section.				
					Feet.	*Feet.*	
1	17 S.	53 E.	23	Spring			
2	17 S.	53 E.	27	Horseshutem Spring			Good water; yields 200 barrels a day.
3	17 S.	53 E.	36	Crystal Spring			
4	18 S.	54 E.	6	Rainbow Spring			Good water; yields 45 barrels a day.
5	18 S.	55 E.	19	Wheeler well			Yields several barrels a day.
6	19 S.	54 E.	14, 23	Horse Springs			Yields a few barrels a day.
7	19 S.	55 E.	3	Buck Spring			Do.
8	20 S.	52 E.	6	Formerly a spring	8	Dry.	
9	20 S.	52 E.	7	do	6	Dry.	
10	20 S.	52 E.	1	Sixmile Spring		6	
11	20 S.	53 E.	15	F. A. Buol	150, 150, 160, 300, 520	Flow.	Five wells reported.
12	20 S.	53 E.	15	J. M. Raycraft	170	Flow.	Three 10-inch wells; flow struck at 156 feet; flows of about 35, 35, and 260 gallons a minute. Also spring flowing about 10 gallons a minute.
13	20 S.	53 E.	14	do	322	Flow.	Drilled well; 30 feet to ground water; flow at 285 feet.
14	20 S.	53 E.	14	Pahrump Valley Co. (springs).			See discharge measurements (p. 63).
15	20 S.	53 E.	14	Pahrump Valley Co	254, 322, 516	Flow.	Three wells. See records (fig. 5), discharge measurements (p. 64), and analysis of 254-foot well.
16	20 S.	53 E.	22	J. M. Raycraft	520	Flows.	
17	20 S.	55 E.	2	Spring			

[a] All locations with "south" township numbers refer to Mount Diablo base and meridian; all with "north" township numbers to San Bernardino base and meridian.

Records of wells and springs in Pahrump, Mesquite, and Ivanpah valleys, Nev.-Calif.—Continued.

No. on Plate VIII.	Location. Township.	Range.	Section.	Owner of well or name of spring.	Depth of well.	Depth to water in well August, 1916.	Remarks.
					Feet.	*Feet.*	
18	20 S.	56 E.	5	Lees Spring			Good water. See discharge measurements (p. 61).
19	20 S.	56 E.	3	Spring			
20	20 S.	56 E.	15	Trout Spring			Good water; flows 100 barrels a day. See discharge measurements (p. 62).
21	20 S.	56 E.	29	Spring			Slight flow.
22	20 S.	56 E.	31	Intermittent Spring			See discharge record (p. 62) and analysis.
23	20 S.	56 E.	31	Spring			Good water; yields 4 barrels a day.
24	20 S.	57 E.	27	do			Yields 50 barrels a day.
25	24 N.	8 E.	28	B. P. Buchanan	40	38	See analysis.
26	21 S.	53 E.	1	Oasis Land Co	416	32	
27	21 S.	53 E.	23	Spring			Flow about 1 quart a minute to cattle trough.
28	21 S.	53 E.	25	Oasis Land Co	210	23	
29	21 S.	54 E.	3	Hoffman & Vetter (Manse Springs).			Discharge, $2\frac{3}{4}$ second-feet. See analysis (smaller spring).
30	21 S.	54 E.	22	Spring			Has summer flow of ½ gallon a minute at 69° F.; unused.
31	21 S.	54 E.	28	Oasis Land Co	163	23	Water struck at 39 feet, rose to 23 feet; drilling in August, 1916.
32	21 S.	54 E.	28	do	135	Flows.	Ground water at 35 feet. At Mound Spring.
33	21 S.	54 E.	28	do	535	Flows.	Ground water at 28 feet; flow 1 gallon a minute at 72° F.
34	21 S.	54 E.	28	do	230	Nearly at surface.	Water struck at about 20 feet, rose nearly to surface.
35	21 S.	54 E.	28	do	165	14	
36	21 S.	56 E.	19	Spring			Is source of Pahrump Valley creek.
37	21 S.	56 E.	19	do			Flow in August, 1916, 0.63 second-feet.
38	21 S.	57 E.	5	Coal Spring			
39	21 S.	57 E.	7	Roses Spring			Reported flow of more than 10 miner's inches.
40	22 S.	54 E.	6	—— Spanker	165 165	23 23	Two drilled wells.
41	22 S.	54 E.	6	do	35	23	Test well; pumping test of 15 miner's inches for 3 hours.
42	22 S.	54 E.	14	Spring			Fair water; yields 10 barrels a day.
43	22 S.	54 E.	27	do			Fair water; yields 15 barrels a day.
44	22 S.	55 E.	30	J. B. Yount	320	6	Test well. All clay except quicksand at 225–230 feet, with water under pressure.
45	22 S.	55 E.	30	do	10–15	7–10	Three wells and windmills. See Pl. X, *C*, and analysis of easternmost well.
46	22 S.	57 E.	15	Mule Spring			Good water; yields 15 barrels a day.
47	22 S.	58 E.	20	Mountain Spring			Good water; yields 20 barrels a day.
48	21 N.	10 E.	16	Dry well			
49	23 S.	55 E.	5	Stump Spring			Fair water; yields 20 barrels a day.
50	23 S.	57 E.	1	Potosi mine spring			Good water; yields 40 barrels a day.
51	20 N.	12 E.	30	R. M. Pettis	82	Dry.	
52	20 N.	12 E.	28	R. W. Barry	67	66	Dug; 0.50 foot, red-brown calcareous clay; 50–67 feet, white clay.
53	20 N.	12 E.	33	O. S. Erickson	57	Dry.	Dug in wash; clay.
54	20 N.	12 E.	33	Mike Ryman	71+	67	Centrifugal-pump pit, 71 feet deep; drilled well in bottom.
55	20 N.	12 E.	33	O. S. Erickson	[a]1,083	56	Water struck at 135 feet, rose to 56 feet; at oil-well rig.
56	20 N.	12 E.	34	G. W. Mitchell	41	40	Dug test well.
57	20 N.	12 E.	34	do	37	Dry.	Do.

[a] Reported.

Records of wells and springs in Pahrump, Mesquite, and Ivanpah valleys, Nev.-Calif.—Continued.

No. on Plate VIII.	Location. Town-ship.	Range.	Sec-tion.	Owner of well or name of spring.	Depth of well.	Depth to water in well August, 1916.	Remarks.
					Feet.	*Feet.*	
58	20 N.	12 E.	34	Charles Heidecke	41	38	Dug. See analysis.
59	20 N.	12 E.	34	do	37	36	Dug; test well.
60	20 N.	12 E.	35	C. M. Gay	39	38	Do.
61	24 S.	57 E.	31		500	58	Two drilled wells, 12 feet apart; good supply reported at 135 feet.
62	24 S.	58 E.	6	Keystone Spring			Good water; yields 15 barrels a day.
63	24 S.	58 E.	25	Good springs	30±		Formerly flowing springs; now shallow wells.
64	19 N.	12 E.	2	W. A. Tritt	29	27	Dug; windmill; domestic use. See analysis.
65	19 N.	12 E.	10	J. H. Pate	43	Dry.	Dug.
66	19 N.	12 E.	11	J. H. Burke	30	29	Dug; test well.
67	19 N.	12 E.	11	do	28	27	Dug; centrifugal pump.
68	19 N.	12 E.	12	C. M. Hill	18	Dry.	Dug; test well.
69	19 N.	12 E.	9		55	54	Dug.
70	19 N.	12 E.	14	C. A. Burke		28	12 inch, drilled.
71	19 N.	12 E.	13	H. A. Hoffman (Osborn well).	17	Dry.	Caved; 12-inch casing.
72	19 N.	13 E.	19	J. B. Yount	11	8	Two dug wells and windmills; cattle watering. See analysis (west well).
73	19 N.	13 E.	20	Roses well	6	Dry.	
74	25 S.	57 E.	5	Old Sandy Mill well	56	52	Dug; windmill, tank, and watering trough. See analysis.
75	25 S.	57 E.	5		50	48	Dug; small engine and pump in center of Platina.
76	25 S.	57 E.	5	J. B. Cryor	50	48	Dug; windmill. See analysis.
77	25 S.	57 E.	4	Boss mine	65	58	Dug; mine supply.
78	25 S.	57 E.	9		36	35	Dug; test well.
79	25 S.	57 E.	17		25	Dry.	Dug.
80	25 S.	57 E.	22		23	22	Dug; test well.
81	25 S.	57 E.	26		8	8	Do.
82	25 S.	57 E.	26			2	Pits dug by Indians at base of sand ridges.
83	25 S.	57 E.	36		42	Dry.	Dug.
84	18 N.	13 E.	5			4	Brine; in pits at old salt works.
85	18 N.	13 E.	8		15	12	Dug; at abandoned adobe house.
86	18 N.	13 E.	12	Bullock's well	56	52	Dug; hand pump; supply for prospectors and for Milford mine. See analysis.
87	26 S.	59 E.	2	Los Angeles & Salt Lake R. R.	687	199	At Borax siding. Abandoned, 14-inch well.
88	26 S.	59 E.	34	George Morgan	91	91	Drilled; test well; clay, to fine sand with fair water at bottom.
89	27 S.	59 E.	8	Old "Borax Team" well.	92	90	Dug; unused. See analysis.
90	27 S.	61 E.	7	Railroad Spring			Fair water; yields 20 barrels a day.
91	17 N?	13 E?	23, 24?, 25	Springs			Slight flows; in unsurveyed township.
92	17 N?	13 E?	35?	do			Do.
93	16 N.	13 E.		Mexican well	5	2	In sandy wash; good supply. See analysis.
94	16 N?	13 E?	13?	Mescal Spring			Yields 200 barrels a day.
95	16 N.	14 E.	31	Roseberry Spring			Yields about 10 barrels a day.
96	16 N.	15 E.	6	S. E. Yates	91	81	Dug; unused. See analysis.
97	16 N.	15 E.	12	Los Angeles & Salt Lake R. R.	506	275	See record (fig. 5) and analysis.
98	16 N.	15 E.	17	Roy White	88	77	12-inch drilled well.
99	16 N.	15 E.	21	A. Dixon	120	79	Do.
100	16 N.	15 E.	33	A. E. Weaber	120	87	Do.
101	16 N.	15 E.	33	Chris. Mattly	120 120	82½ 84	Two wells; 12-inch, drilled.
102	16 N.	15 E.	32	San Francis	92	90	Dug; good water.
103	16 N.	15 E.	33	Ruben Buchner	412	88	See record (fig. 5) and analysis.

Records of wells and springs in Pahrump, Mesquite, and Ivanpah valleys, Nev.-Calif.—Continued.

No. on Plate VIII.	Location.			Owner of well or name of spring.	Depth of well.	Depth to water in well August, 1916.	Remarks.
	Township.	Range.	Section.				
					Feet.	*Feet.*	
104	28 S.	61 E.	8	At Crescent, wells 30+			Shallow dug wells in wash.
105	28 S.	61 E.	10	Water hole			Fair water; yields 15 barrels a day.
106	15½ N.	15 E.	3	Murphy well	116	92	Dug; walled with 3-foot tile casing with 12-foot crosscut at bottom; cement lined. Can be pumped dry in 4 hours at rate of 20 gallons a minute. On Oct. 26, 1917, the depth to water was 100 feet. See analysis.
107	15 N.	14 E.	2	Mineral Spring			Fair water.
108	15 N.	15 E.	13	Los Angeles & Salt Lake R. R.	530	370	See record (fig. 5) and analysis.
109	15 N.	16 E.	36	Willow Spring			Good water; yields 50 barrels a day.
110	15 N.	17 E.	19	Dove Spring			Do.
111	14 N.	13 E.	23	Cut Spring			Yields 50 barrels a day. See analysis.
112	14 N.	13 E.	25	White Rock Spring			Yields 40 barrels a day.
113	14 N.	14 E.	18	Kessler Spring			Yields 100 barrels a day See analysis.
114	14 N.	15 E.	23	Spring			
115	14 N.	15 E.	28	Cottonwood Spring			
116	14 N.	15 E.	27	Spring			
117	14 N.	16 E.	9	Slaughterhouse Spring			Good water; yields 75 barrels a day.
118	14 N.	16 E.	16	Mexican Spring			
119	16 N?	16 E.	33?	Wheaton Spring			Water piped from tunnel in granite 100 yards to galvanized-iron trough; flows about 100 barrels a day.
120	13 N.	14 E.	5	At Cima	135	Dry.	Dug; test well. No water struck.
121	13 N.	15 E.	8	Spring			
122	13 N.	15 E.	18	....do			

QUALITY OF WATER.

CLASSIFICATION.

Samples of water from 12 wells and 3 springs in the three basins under consideration were collected by the writer and analyzed under contract by S. C. Dinsmore, Reno, Nev. Four additional samples, three from wells and one from a spring, were collected by David G. Thompson in the fall of 1917 and were analyzed in the laboratory of the water-resources branch of the United States Geological Survey. One analysis of water from a well owned by the Los Angeles & Salt Lake Railroad Co. was furnished by that company. The results of the analyses, together with a classification of the waters for domestic, boiler, and irrigation use, are given in the table opposite page 80.

The classification[1] of waters for domestic use, as given in the table, is based on the determinations of the dissolved mineral constituents and their chemical character. The suitability of a water for domestic use depends on its acceptability for drinking, washing,

[1] Mendenhall, W. C., Dole, R. B., and Stabler, Herman, Ground water in San Joaquin Valley, Calif.: U. S. Geol. Survey Water-Supply Paper 398, pp. 73–82, 1916.

and cooking, as determined chiefly by the amounts of iron, nitrate, and chloride in solution and by the hardness of the water. Waters high in hardening constituents can be used for drinking, but they are unsatisfactory for cooking and laundering. Hardness exceeding 1,500 parts per million makes water unfit for cooking. The hardness sufficient to cause prohibitive soap consumption in washing is much less than that which makes water undesirable for cooking.

The presence of approximately 200 parts per million of carbonate, 250 parts of chloride, or 300 parts of sulphate may give the water a slight taste. Waters containing considerably more of these constituents can be tolerated by human beings, but those which contain more than 300 parts per million of carbonate, 1,500 parts of chloride, or 2,000 parts of sulphate are intolerable to most people. Local conditions and individual preference, however, largely determine the significance of the terms "good" or "bad," as applied to the mineral quality of water for domestic use. For instance, in a desert region a water containing 240 parts per million of hardness might be classed as fair; in a region where the supply is abundant and the quality is in general much better, as in the New England States, the same water would be classed as bad by most users. It should be borne in mind in this report that the classification of a water for domestic use is based only on its mineral content, and although certain determinations afford indications of the sanitary quality of the water they may not permit a complete sanitary interpretation. A water may contain only small amounts of dissolved solids and yet be so badly polluted as to be unsafe for drinking.

With respect to their quality for use in boilers, waters are first classified according to their scale-forming and foaming constituents and the probability of corrosion, and from these data the advisability of their use is determined. Scale is formed in boilers by certain substances that go out of solution on heating and concentration of the water. Foaming, or the formation of masses of bubbles in the boiler, is caused by certain salts or by fine mud or other matter in the water. The corrosion or pitting of the walls and tubes of boilers is caused by electrolytic action, which may be accelerated or retarded by the presence of various substances in solution.

Rating of waters for boiler use according to proportions of incrusting and corroding constituents and according to foaming constituents.

Incrusting and corroding (scale-forming) constituents.		Foaming constituents.	
Parts per million.	Classification.[a]	Parts per million.	Classification.[b]
Not more than 90	Good	Not more than 150	Good.
91 to 200	Fair	151 to 250	Fair.
201 to 430	Poor	251 to 400	Bad.
More than 430	Bad	More than 400	Very bad.

[a] Am. Ry. Eng. and Maintenance of Way Assoc. Proc., vol. 5, p. 595, 1904.
[b] Idem, vol. 9, p. 134, 1908.

Mineral analyses and classification of ground waters from Pahrump, Mesquite, and Ivanpah basins, Nev.-Calif.

[Parts per million except as otherwise designated. S. C. Dinsmore, analyst.]

No. on Plate VIII.[a]	Date of collection.	Determined quantities.											Computed quantities.[b]				Classification.[b]					
		Silica (SiO_2).	Iron (Fe).	Calcium (Ca).	Magnesium (Mg).	Sodium and potassium (Na+K).[c]	Carbonate radicle (CO_3).	Bicarbonate radicle (HCO_3).	Sulphate radicle (SO_4).	Chloride radicle (Cl).	Nitrate radicle (NO_3).	Total dissolved solids at 180° C.	Total hardness as $CaCO_3$.	Scale-forming constituents.	Foaming constituents.	Alkali coefficient (inches).	Mineral content.	Chemical character.	Probability of corrosion.[d]	Quality for boiler use.	Quality for domestic use.	Quality for irrigation.
	Pahrump basin.																					
15	1916. Aug. 29	8.0	Trace.	51	25	42	0.0	242	32	63	Trace.	383	230	200	110	32	Moderate	Ca-CO_3	(?)	Fair	Fair	Good.
22	Aug. 24	10	0.00	59	24	4.3	.0	273	22	5.0	1.5	251	246	220	12	383	do	do	(?)	do	do	Do.
25	Aug. 26	36	.35	38	41	107	7.2	370	94	58	.00	537	263	220	290	14	High	Na-CO_3	N	Poor	do	Fair.
29	Aug. 27	18	Trace.	55	29	Trace.	.0	239	42	4.9	.00	268	256	230	0	416	Moderate	Ca-CO_3	(?)	Fair	do	Good.
45	do	13	.45	58	30	20	.0	266	58	24	.00	338	268	230	54	81	do	do	(?)	do	do	Do.
	Mesquite basin.																					
58	1916. Aug. 26	23	Trace.	57	42	16	0.0	217	136	20	2.0	403	315	260	43	97	Moderate	Mg-CO_3	(?)	Fair	Poor	Good.
64	Aug. 27	26	.20	76	84	66	.0	278	334	73	Trace.	823	534	390	180	26	High	Mg-SO_4	C	Bad	do	Do.
72	Aug. 25	53	Trace.	31	45	140	.0	307	156	108	.00	694	262	220	280	16	do	Na-CO_3	(?)	do	Fair	Fair.
74[e]	1917. Oct. 28	24	.16	80	45	30	.0	273	189	20	1.8	542	384	340	81	81	do	Ca-CO_3	(?)	Poor	Poor	Good.
76	1916. Aug. 27	18	.20	61	41	26	.0	256	122	29	Trace.	435	321	270	43	65	Moderate	do	(?)	Fair	do	Do.
86	Aug. 25	35	Trace.	69	37	[f] 406	.0	224	207	551	.00	1,445	324	300	1,100	3.6	High	Na-Cl	(?)	Very bad	do	Poor.
	Ivanpah basin.																					
89	1916. Aug. 25	23	.20	480	441	8,927	0.0	844	3,921	12,489	0.00	27,501	3,010	2,200	2,500	0.5	Very high	Na-Cl	C	Unfit	Unfit	Bad.
93[e]	1917. Oct. 27	45	.27	79	48	96	.0	342	189	88	2.4	746	394	360	260	20	High	Na-CO_3	(?)	Poor	Poor	Good.
96	1916. Aug. 24	30	Trace.	201	158	2,416	.0	402	429	3,984	.00	7,702	1,150	880	6,500	.5	Very high	Na-Cl	C	Unfit	Unfit	Bad.
97[g]	1915. Oct. 28	[h] 17		26	19	[i] 107	.0	154	49	139		[j] 433	143	120	290	14	Moderate	do	(?)	Bad	Good	Fair.
103	1916. Aug. 24	41	1.4	15	5.0	101	12	171	31	61	.00	372	58	94	270	9.9	do	Na-CO_3	N	Fair	do	Do.
106[e]	1917. Oct. 26	59	.33	28	20	55	.0	211	51	30	2.8	335	152	180	150	28	do	do	N	do	do	Good.
108	1916. Aug. 24	17	.30	26	4.1	49	.0	73	73	35	5.0	240	82	100	130	47	do	Na-SO_4	(?)	Good	do	Do.
111[k]	1917. Nov. 6	45	.66	67	18	44	.0	236	61	57	.05	433	241	270	120	34	do	Ca-CO_3	(?)	Poor	Fair	Do.
113	1916. Aug. 23	36	Trace.	67	17	35	.0	178	58	71	9.0	406	237	260	95	29	do	do	(?)	Fair	do	Do.

[a] For descriptive data see records corresponding in number on pp. 76-79.
[b] See standards for classification by R. B. Dole and Herman Stabler in U. S. Geol. Survey Water-Supply Paper 398, pp. 50-82, 1916.
[c] Computed.
[d] Based on computed value; C=corrosive; N=noncorrosive; (?)=corrosion doubtful.
[e] Analyzed by C. H. Kidwell, U. S. Geological Survey.
[f] Determined; Na=341 and K=65 parts per million.
[g] Analysis furnished by Los Angeles & Salt Lake R. R., recalculated from hypothetical combinations in grains per United States gallon; analyst, Dearborn Chemical Co.
[h] Includes $Fe_2O_3+Al_2O_3$.
[i] Determined.
[j] By summation.
[k] Analyzed by F. E. Keating, U. S. Geological Survey.

With respect to their value for irrigation, waters are classified according to their content of salts toxic to vegetation. Water containing considerable quantities of sodium salts or other alkali salts[1] is injurious to vegetation, because, through evaporation, the alkali collects in the few inches of top soil in such quantities as to interfere greatly with the growth of plants. The irrigating value of a water with respect to the amount of contained alkali is expressed by the term "alkali coefficient,"[2] which is defined as the depth of water in inches which on evaporation would yield sufficient alkali to render the soil to a depth of 4 feet injurious to the most sensitive crops. The coefficient affords a purely arbitrary means of comparing waters used for irrigation. It does not take account of certain important factors, such as the methods of irrigation and of drainage, the character of the soil, and the kind of crop, but it indicates very well the general suitability of the water for irrigation. The waters in the areas here discussed have been classified as to quality for irrigation in accordance with the following rating, which is based on ordinary irrigation practice in the United States and which indicates in a very general way the customary limitation in the use of waters having various alkali coefficients.

Classification of water for irrigation.[a]

Alkali coefficient (inches).	Class.	Remarks.
More than 18	Good	Have been used successfully for many years without special care to prevent alkali accumulation.
18 to 6.0	Fair	Special care to prevent gradual alkali accumulation has generally been found necessary except on loose soils with free drainage.
5.9 to 1.2	Poor	Care in selection of soils has been found to be imperative, and artificial drainage has frequently been found necessary.
Less than 1.2	Bad	Practically valueless for irrigation.

[a] Stabler, Herman, Some stream waters of the western United States, with chapters on sediment carried by the Rio Grande and the industrial application of water analyses: U. S. Geol. Survey Water-Supply Paper 274, p. 179, 1911. See also U. S. Geol. Survey Water-Supply Paper 398, p. 57, 1916.

ANALYSES.

The waters analyzed from the Pahrump, Mesquite, and Ivanpah basins vary in mineral content from moderate to very high. The lowest amount of total solids is 240 parts per million, from well No. 108, and the highest is 27,501, from well No. 89. Both of these waters come from the Ivanpah basin. The waters analyzed are mostly good or fair for irrigation, cooking, and drinking, but average somewhat poorer for washing and boiler use. A detailed discussion of the quality of the water from each basin will be found in the descriptions of the basins.

[1] The term "alkali" is used to designate the common salts formed on evaporation of natural waters. The principal alkali salts are sodium carbonate (sal soda), or black alkali, and sodium sulphate (Glauber's salt) and sodium chloride (table salt), or white alkalies.

[2] Stabler, Herman, Some stream waters of the western United States: U. S. Geol. Survey Water-Supply Paper 274, pp. 177–179, 1911.

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