Darrough Hot Spgs
GL01955

Jour. Research U.S. Geol. Survey
Vol. 2, No. 5, Sept.-Oct. 1974, p. 599—608

STRATIGRAPHY, STRUCTURE, AND GEOLOGIC HISTORY OF THE LUNAR LAKE CALDERA OF NORTHERN NYE COUNTY, NEVADA

By E. B. EKREN, W. D. QUINLIVAN, R. P. SNYDER; and F. J. KLEINHAMPL;
Denver, Colo.; Menlo Park, Calif.

Prepared in cooperation with the U.S. Atomic Energy Commission

Abstract.—The Lunar Lake caldera is in northern Nye County, Nev., about 70 mi (110 km) east-northeast of Tonopah. It is the youngest caldera in the central Nevada multiple-caldron complex and the source of the tuff of Lunar Cuesta, a multiple-flow simple cooling unit of quartz latitic welded tuff that is about 25 m.y. old. The tuff was distributed over an area of nearly 3,000 mi² (7,770 km²) and has a volume of approximately 90 mi³ (375 km³). The Lunar Lake caldera is adjacent of the Lunar Crater basalt field which contains basalts of Pleistocene and probably Holocene age. These basalts were fed from northeast-trending fissures that had much earlier served as vents for ash-flow tuffs and lavas, possibly including the tuff of Lunar Cuesta.

U.S. Geological Survey investigations in central Nevada on behalf of the U.S. Atomic Energy Commission have led to the recognition of a multiple-caldron complex (U.S. Geological Survey, 1970, p. A39–A40). The boundaries of this caldron complex have been delineated by a combination of geological and geophysical (gravity, aeromagnetic, reflection seismograph) techniques and information from several deep drill holes. Ash-flow tuffs that can reasonably be inferred to have been extruded from the caldron complex include the Windous Butte Formation (Cook, 1965), which is the most widespread and possibly the oldest (30.7 m.y., according to Grommé and others, 1972), and the tuff of Lunar Cuesta, which is about 25 m.y. old and one of the youngest. This report is concerned primarily with the tuff of Lunar Cuesta, whose extrusion resulted in the formation of the present-day topographically expressed Lunar Lake caldera. Rock units that are closely related to the tuff of Lunar Cuesta in time and space are also discussed.

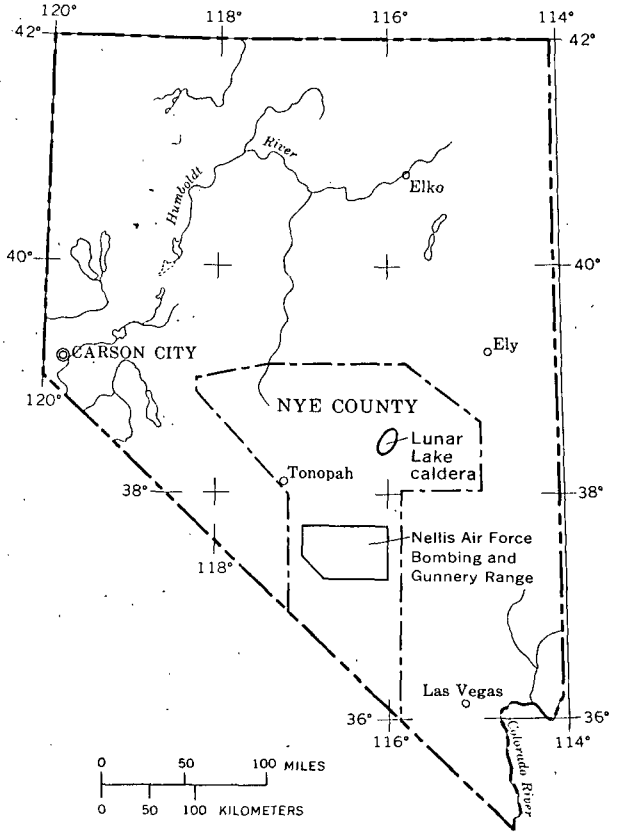


Figure 1.—Map of Nevada showing location of Lunar Lake caldera.

GEOLOGIC SETTING

The Lunar Lake caldera (fig. 1) is in northern Nye County, Nev., approximately 70 mi (110 km) east-northeast of Tonopah. It lies in the southeastern part of the central Nevada multiple-caldron complex (fig. 2), within which ash-flow tuffs and genetically related lavas probably average at least 7,000 ft (2,130 m) in thickness. Drill hole HTH-3, for example, in the central part of the complex (fig. 2) collared in the tuff of Williams Ridge and Morey Peak (Ekren, Hinrichs, and others, 1974) and bottomed in the same unit at a depth of 6,000 ft (1,830 m). We have inferred (U.S. Geological Survey, 1970, p. A39–A40) that this tuff is genetically related to the Windous Butte Formation, and recent paleomagnetic studies suggest that it may be coextensive with the upper part of the Windous Butte.

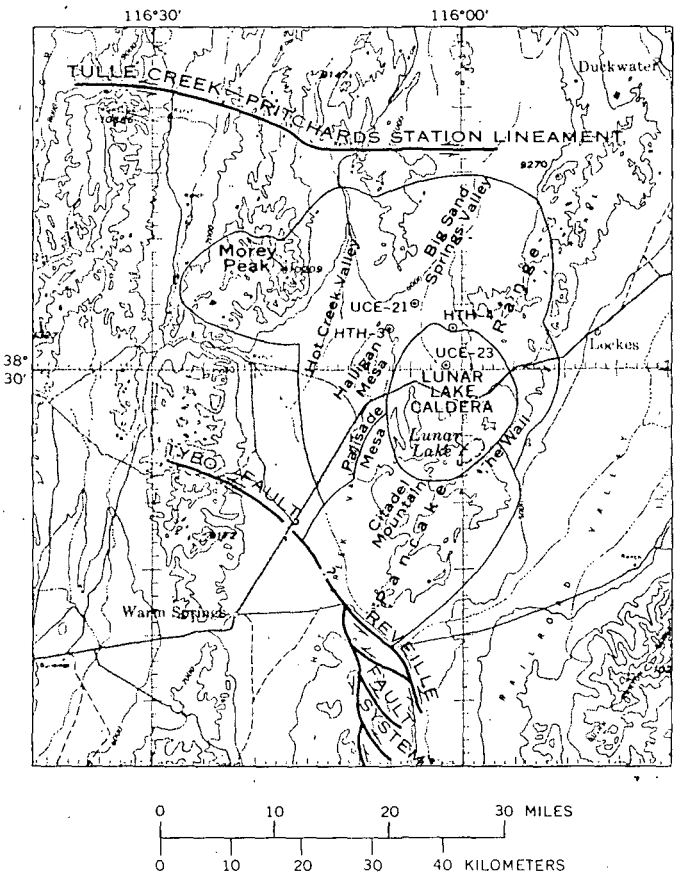


Figure 2.—Map showing location of Lunar Lake caldera with respect to the central Nevada caldron complex, the Tybo and Reveille strike-slip faults, and the Tulle Creek-Pritchards Station lineament, ⊙, Drill hole. Base from U.S. Coast and Geodetic Survey Reno Sectional Aeronautical Chart, 1:500,000, 1958–65.

Except for the strata exposed in the southern Pancake Range in and adjacent to the Lunar Lake caldera, all rocks in the area of the multiple-caldron complex are intensely faulted and fractured, and every drill hole within the complex (see geologic map of the Moores Station quadrangle, by Ekren, Hinrichs, and others, 1974) penetrated highly fractured and faulted rocks. The complex is bounded on the north by the east-trending Tulle Creek–Pritchards Station aeromagnetic lineament along which some left-lateral strike-slip movement has been inferred by Ekren, Bath, Dixon, Healey, and Quinlivan (1974). The complex is inferred to have been cut on the south and southwest by the northwest-trending left-lateral Tybo and Reveille strike-slip faults (Quinlivan and Rogers, 1974; Ekren, Rogers, and Dixon, 1974).

The Lunar Lake caldera is the site of the Lunar Crater basalt field. According to Scott and Trask (1971) the basaltic rocks include subalkaline, alkaline, and basanitoid types and contain a variety of xenoliths, some of which are inferred to have been derived from the upper mantle. The basalt lavas and pyroclastic ejecta were vented from a series of northeast-trending fissures (fig. 3). Chains of cinder cones that overlie the fissure zones are confined to the larger caldron complex but between the Lunar Lake caldera on the northeast and southwest sides. The northeast-trending fissure zones were also the vents for several of the pre-basalt volcanic units, possibly including the tuff of Lunar Cuesta.

STRATIGRAPHY

The Tertiary volcanic units of the Lunar Lake caldera area (fig. 3) have been described in detail on the geologic maps of the Lunar Crater quadrangle (Snyder and others, 1972) and The Wall quadrangle (Ekren, Hinrichs, and Dixon, 1973). The units will be very briefly described herein. With the exception of the Shingle Pass Tuff whose source is inferred to have been outside the central Nevada caldron complex (Sargent and Houser, 1970), the units are typically calc-alkaline and are petrographically and chemically extremely similar.

Rocks older than the tuff of Lunar Cuesta

Rocks older than the tuff of Lunar Cuesta form the layer-cake stratigraphy of Palisade and Halligan Mesas (fig. 3) and the beautiful stratiform exposures of these rocks are primarily responsible for the name "Pancake Range." They include at the base of the exposure the tuff of Williams Ridge and Morey Peak, which consists of two lithologically identical cooling units in drill hole HTH-3 and in the vicinity of Black Rock Summit (figs. 3, 5). Both are multiple-flow compound cooling units of phenocryst-rich quartz latite (table 1, samples 12, 13). This tuff apparently underlies much of the central Nevada caldron complex (fig. 2), where it has great thickness and is inferred to have been erupted concurrently with caldron subsidence after the main extrusions of the Windous Butte Formation (table 1, samples 14, 15) had ceased.

The tuff of Williams Ridge and Morey Peak is overlain on Halligan and Palisade Mesas (fig. 3) by the tuff of Halligan Mesa and in the vicinity of Black Rock Summit by the tuff of Black Rock Summit. The tuff of Halligan Mesa is 500–600 ft (150–180 m) thick; it is a multiple-flow compound cooling unit of moderately phenocryst-rich rhyolite which is characterized by a high percentage of quartz that is amethyst to dark smoky, bipyramidal in habit, and as much as 5 mm in diameter (table 1, sample 10). The unit is nearly completely free of lithic fragments. The tuff of Black Rock Summit, on the other hand, contains only 12–25 percent phenocrysts of plagioclase, biotite, and pseudomorphs after hornblende and pyroxene. Despite its basic suite of phenocrysts the tuff is rhyolitic in composition (table 1, sample 11). In exposures south of U.S. Highway 6 the tuff of Black Rock Summit is conspicuously flow layered and laminated. The laminar flowage structures are so well developed that the rock is unrecognizable as a tuff except in the basal 50–100 ft (15–30 m). The tuff at the top of the exposures has ramp structures similar in all respects to

ctures at the top of lava flows. The tuff is overlain without obvious cooling break by flow breccia and lava having the e phenocryst mineralogy as the tuff. These features ongly suggest extrusion of both lava and tuff from the eral vicinity of Black Rock Summit, and it is inferred that laminar flowage structures developed as a result of faulting t probably occurred concurrently with tuff eruption. This rence is made because the tuff of Black Rock Summit does seem to be the type of tuff that would flow under stable itions. The tuff is chemically unlike ash-flow tuffs that on very gentle slopes under small static load conditions, as the Grouse Canyon Member of Belted Range Tuff in thern Nevada (Hoover, 1964), the tuff of Wagontire Moun- in Oregon (Walker and Swanson, 1968), and the Precam- n tuffs of southeastern Missouri (Anderson, 1970). All e tuffs are characterized by low Al_2O_3 and by high Na_2O d total-iron contents, unlike the tuff of Black Rock Summit ble 1, sample 11).

Overlying the tuff of Halligan Mesa is the tuff of Palisade sa, a multiple-flow compound cooling unit of phenocryst- rhyolite and quartz latite (table 1, sample 9). This unit is spicuously columnar jointed where it is 400–500 ft 22–152 m) thick on Palisade Mesa and it is overlain by the notony Tuff (Ekren and others, 1971). The tuff of Williams ge and Morey Peak and the tuffs of Halligan and Palisade sas appear to have been erupted in rapid succession without sional intervals between eruptions; at least, we know o unconformities or pronounced disconformities between se units, all of which are thought to be genetically related. Monotony Tuff (Ekren and others, 1971), in contrast, has pronounced angular unconformity in places at its base, and ally it is separated from older units by coarse gravels. The notony, however, on the basis of similarity with older and nger units (table 1, sample 8) and its areal distribution, is rred to have its source in the central Nevada multiple- ldron complex, and its caldera, as will be discussed later in s report, is overlapped and truncated by the Lunar Lake ldera.

The tuff of Big Round Valley (Quinlivan and others, 1974) ps out over several square miles north of Black Rock Sum- and northeast of the Lunar Lake caldera. The tuff consists two cogenetic multiple-flow compound cooling units that e an aggregate thickness of 700 ft (210 m), both of which mble the tuffs of Halligan and Palisade Mesas in composi- n and phenocryst mineralogy. The tuff of Big Round Valley not believed correlative with them, however, as it is nearly ywhere separated from the tuff of Williams Ridge and ey Peak by the tuff of Black Rock Summit, which was ted before emplacement of the tuff of Big Round Valley is overlain conformably by the Monotony Tuff. An erup- center for the tuff of Big Round Valley has not been ntified.

Rocks younger than the tuff of Lunar Cuesta

Rocks younger than the tuff of Lunar Cuesta from oldest to youngest are the rhyolite of Big Sand Springs Valley, the tuff of Buckskin Point, quartz latite and andesite lavas, tuff of Buckwheat Rim, tuff of Black Beauty Mesa, and a tuff referred to informally as "granite-weathering tuff." With the exception of the last named, all units were extruded from the Lunar Lake area, but these extrusions did not give rise to calderas. All but the rhyolite lavas are thickest in the vicinity of Citadel Mountain, and they are inferred to have been extruded from a southwestward extension of the same northeast-trending faults that later served as conduits for the rising basalts. The rhyolite lavas (rhyolite of Big Sand Springs Valley, fig. 3) were erupted from multiple vents in caldron ring-fracture zones along the southeastern and northern sides of the caldera. At localities A and B (fig. 3) the rhyolite filled two sharp scallops that formed during collapse of the caldera. The rhyolite in these scallops obviously was erupted very shortly after the tuff of Lunar Cuesta was extruded, as indicated by the preservation of the vapor-phase top of the tuff of Lunar Cuesta in these areas. Along the northern flank, however, the rhyolite lavas rest on older strata. Either this northern area underwent extremely rapid erosion after the eruption of the tuff of Lunar Cuesta or the tuff was never deposited there because of high paleotopography. The rhyolite is nearly aphyric and contains no more than 4 percent tiny phenocrysts of quartz, feldspar, and biotite (table 1, sample 1).

South of the Lunar Lake caldera, the tuff of Lunar Cuesta is overlain by the tuff of Buckskin Point, a multiple-flow compound cooling unit as much as 250 ft (75 m) thick that consists of phenocryst-poor dark-gray rhyodacite (table 1, sample 4) at the base and phenocryst-rich light-gray quartz latite at the top. On the south flank of Citadel Mountain the tuff of Buckskin Point is overlain, without a cooling break, by quartz latitic vent breccia that grades upward into lithic-free, coarse-grained, phenocryst-rich quartz latite lava (fig. 3). The tuff of Buckskin Point is magnetically reversed.

The tuff of Buckskin Point and the local quartz latite lava are overlain by andesite lavas and flow breccias that are dark brownish gray to black and contain 8–30 percent phenocrysts of plagioclase and clinopyroxene and orthopyroxene (table 1, sample 3). These lavas are 1,200 ft (366 m) thick on Citadel Mountain, and, like the tuffs, they thin abruptly to the northwest and southeast. In the vicinity of Buckskin Point (fig. 3), lavas and flow breccias cropping out between the quartz latite and andesite are dacitic and rhyodacitic in composition, indicative of a gradual change in composition from quartz latite to andesite as lava eruptions proceeded.

The andesite lavas are overlain by the tuff of Buckwheat Rim, a multiple-flow compound cooling unit (possibly two

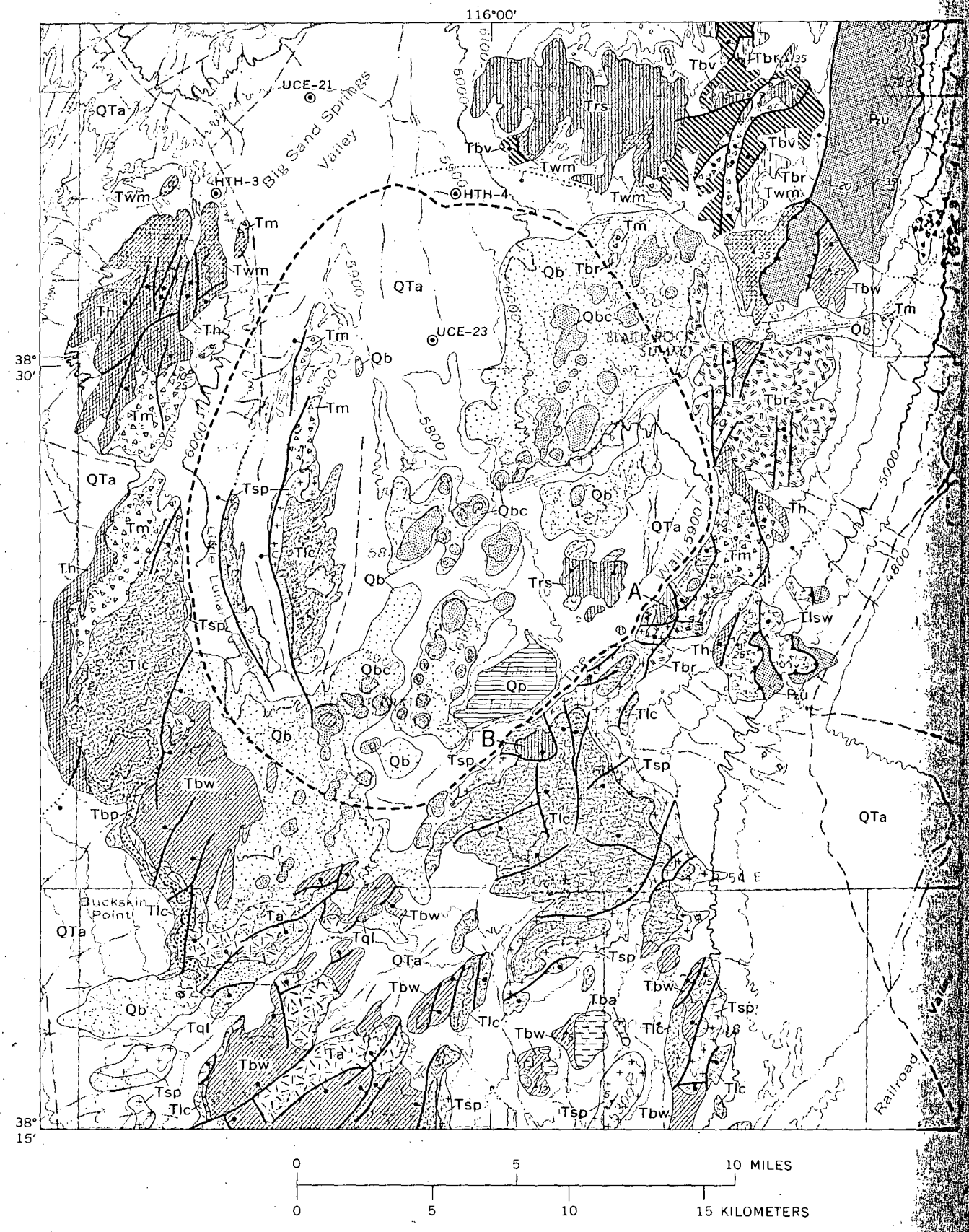
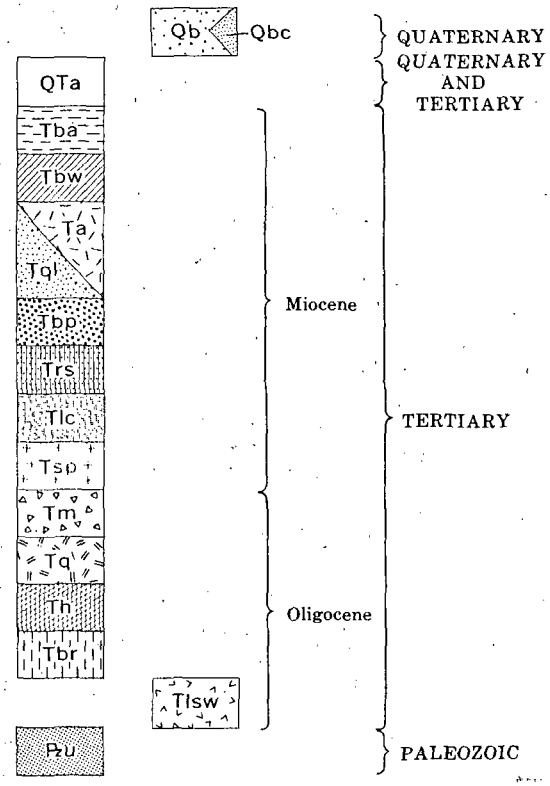
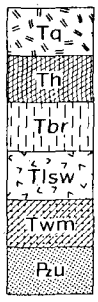


Figure 3.—Geologic map of the Lunar Lake area. Base from U.S. Geological Survey quadrangle maps, 1:250,000 (Tonopah, 1956–62; Lund, 1956–70).

CORRELATION OF MAP UNITS





Quartz latite lava (Oligocene)

Tuffs of Palisade and Halligan Mesas (Oligocene)

Tuff of Black Rock Summit (Oligocene)

Landslipped welded tuff (Oligocene)

Tuff of Williams Ridge and Morey Peak (Oligocene)

Paleozoic rocks

Contact

Fault—Dotted where concealed. Bar and ball on downthrown side

Gravity slide fault—Sawteeth on upper plate

20 Strike and dip of beds

20 Strike and dip of compaction foliation

Buried boundary of Lunar Lake caldera

UCE-23 Drill hole

LIST OF MAP UNITS

Qp Playa deposits (Quaternary)

Basalt (Quaternary)

Qb Lava flows

Qbc Cinder cones

QTa Alluvium and colluvium (Quaternary and Tertiary)

Tba Basaltic andesite (Miocene)

Tbw "Granite-weathering tuff," tuff of Black Beauty Mesa, and tuff of Buckwheat Rim (Miocene)

Intermediate lavas (Miocene)

Ta Andesite

Tql Quartz latite

Tbp Tuff of Buckskin Point (Miocene)

Trs Rhyolite of Big Sand Springs Valley (Miocene)

Tlc Tuff of Lunar Cuesta (Miocene)

Tsp Shingle Pass Tuff (Miocene)

Tm Monotony Tuff (Oligocene)

Tbv Tuff of Big Round Valley (Miocene and Oligocene) —Age relations uncertain

cooling units) as much as 500 ft (150 m) thick that consists of cliff-forming, moderately welded, mafic-poor rhyolite at the base (one-third of unit) and slope-forming, partially welded mafic-rich quartz latite and rhyodacite (table 1, sample 2) at the top (two-thirds of unit). The tuff of Buckwheat Rim is magnetically reversed. On the southwest flank of Citadel Mountain and on Black Beauty Mesa the tuff of Buckwheat Rim is overlain, without an obvious cooling break, by stratified quartz latitic vent breccia having the same phenocryst mineralogy as the underlying welded tuff.

On Black Beauty Mesa (fig. 3) and on local areas to the south and east, the tuff of Buckwheat Rim is overlain by two thin simple cooling units of rhyodacitic densely welded tuff called the tuff of Black Beauty Mesa. These units are indistinguishable in outcrop and in thin section from the basal rhyodacitic tuff of Buckskin Point, but the tuff of Black Beauty Mesa is magnetically normal.

The "granite-weathering tuff" disconformably overlies the tuff of Black Beauty Mesa and other units in the Lunar Lake area. It is quartz-rich rhyolite and everywhere is characterized by chatoyant alkali feldspar. It is very similar to the tuff of White Blotch Spring in the northern Nellis Air Force Base Bombing and Gunnery Range (Ekren and others, 1971) and we presume that it was vented from a center in or near the bombing and gunnery range.

The tuff of Lunar Cuesta

The tuff of Lunar Cuesta is a multiple-flow simple cooling unit of quartz latite; it is typically densely welded, devitrified,

Table 1.—*Chemical analyses, in percent, of selected volcanic rocks in and around the Lunar Lake caldera*

[Values for sample 11, for SiO_2 and Al_2O_3 by X-ray fluorescence, analyst, J. S. Wahlberg; total Fe, MgO, and CaO by atomic absorption, analyst Wayne Mountjoy; Na_2O and [illegible] flame photometer, analyst Wayne Mountjoy; TiO_2 by Tiron colorimetry, analyst Claude Huffman, Jr.; P_2O_5 obtained colorimetrically, analyst G. D. Shipley. Values for [illegible] samples by rapid rock analysis: analysts S. D. Botts, P. L. D. Elmore, G. W. Chloe, J. Kelsey, H. Smith, Lowell Artis, and J. L. Glenn]

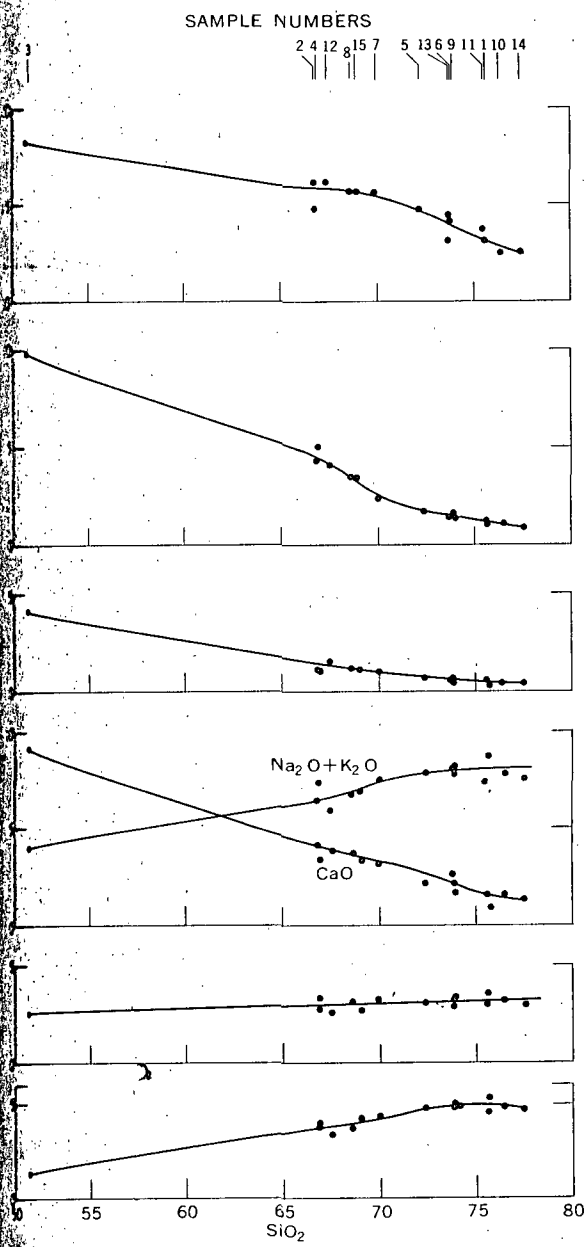
Sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14	[illegible]
Laboratory No.	W178-668	W172-306	W172-302	W172-305	W178-672	W178-676	W178-678	W178-671	W172-139	W172-140	D159-546	W172-143	W172-145	W175-163	[illegible]
Field No.	W-68-BE-18	RS-5E	RS-6	RS-5A	WPC-5	SPC-8	RC-9	RC-3	NPC-33	NPC-26	BE-281-66	NPC-2	NPC-15	70FB-83	[illegible]
SiO_2	75.0	65.2	50.00	65.5	69.8	72.2	69.2	68.0	73.2	74.7	75.1	64.6	71.4	77.6	[illegible]
Al_2O_3	12.9	15.7	17.70	14.4	14.3	12.8	15.3	15.3	13.9	12.2	13.5	15.4	14.1	12.5	[illegible]
Fe_2O_3	.70	3.9	7.80	3.2	1.6	1.1	1.7	3.2	1.1	.84	1.25	3.7	1.5	.72	[illegible]
FeO	.78	.60	2.50	2.0	.40	.48	.70	.50	.44	.24		.44	.28	.16	[illegible]
MgO	.17	1.1	4.00	1.1	.55	.48	1.0	1.1	.37	.37	.37	1.4	.54	.25	[illegible]
CaO	.82	4.0	8.80	3.3	2.0	2.6	3.1	3.7	1.6	1.6	1.44	3.7	2.0	1.3	[illegible]
Na_2O	3.5	2.6	2.50	3.2	2.9	3.1	3.2	3.0	3.3	3.0	2.88	2.4	2.8	2.9	[illegible]
K_2O	5.1	3.6	1.40	3.9	4.6	4.8	4.2	3.5	4.7	4.5	4.41	3.2	4.7	4.6	[illegible]
H_2O+	.49	.80	2.22	1.5	2.9	.43	1.0	1.2	.84	1.0	.....	1.3	1.3	.38	[illegible]
H_2O-	.19	1.2		.50	.88	.38	.78	1.0	.15	.36	.....	2.2	.84	.17	[illegible]
TiO_2	.04	.62	1.90	.93	.20	.15	.26	.42	.20	.13	.21	.64	.27	.06	[illegible]
P_2O_5	.....	.22	.69	.38	.08	.06	.10	.14	.08	.08	.19	.15	.08	.02	[illegible]
MnO	.04	.04	.16	.12	.09	.06	.05	.10	.03	.04	.....	.03	.03	.00	[illegible]
Co_2	.08	.22	.31	<.05	.02	.49	.08	.04	<.05	.28	.....	<.05	<.05	.00	[illegible]
Total	99.81	99.80	99.80	100.03	100.32	99.13	100.07	101.20	99.96	99.34	99.35	99.16	99.84	100.66	[illegible]

1. Rhyolite of Big Sand Springs Valley at lat 38°27′ N., long 115°57′ W. 3.8 percent phenocrysts: quartz 30.9, alkali feldspar 49.1, plagioclase 18.2, biotite 1.8, hornblende tr.
2. Tuff of Buckwheat Rim at lat 38°19′ N., long 116°7 1/2′ W. 49.8 percent phenocrysts: quartz 16.8, alkali feldspar 0.7, plagioclase 49.9, biotite 6.8, opaque minerals 2.1.
3. Andesite lava at lat 38°19′ N., long 116°7 1/2′ W. 25.1 percent phenocrysts: plagioclase 75.7, biotite 1.8, opaque minerals 5.5, clinopyroxene 16.4, hornblende 0.5.
4. Tuff of Buckskin Point at lat 38°19′ N., long 116°7 1/2′ W. 13.5 percent phenocrysts: quartz 4.2, alkali feldspar 6.3, plagioclase 62.1, biotite 8.4, opaque minerals 1.1, hornblende 8.4, pyroxene 1.1, altered mafic minerals 2.1, holes in thin section 6.3.
5. Tuff of Lunar Cuesta at lat 38°23′ N., long 116°11′ W. Modes not counted for samples 5, 6, and 7. Modes of tuff of Lunar Cuesta sampled elsewhere in central Nevada give the following ranges or averages: 20–35 percent phenocrysts: quartz 12–20, alkali feldspar 7–15, plagioclase 45–75, biotite 10–15, hornblende 3, opaque minerals 2.
6. Tuff of Lunar Cuesta at lat 38°14′ N., long 116°3′ W.
7. Tuff of Lunar Cuesta at lat 38°27 1/2′ N., long 116°5′ W.
8. Monotony Tuff at lat 38°28′ N., long 116°5′ W. Mode count for several samples: 25–55 percent phenocrysts: quartz 10–22, alkali feldspar 5–12, plagioclase 46–63, biotite 10–22, hornblende tr–7, clinopyroxene 1–5, orthopyroxene tr, opaque minerals 1–2.
9. Tuff of Palisade Mesa at lat 38°29 1/2′ N., long 116°8′ W. 36.3 percent phenocrysts: quartz 31.4, alkali feldspar 28.1, plagioclase 32.6, biotite 5.1, opaque minerals 1.7, hornblende 1.1.
10. Tuff of Halligan Mesa at lat 38°31′ N., long 116°8′ W. 28.0 percent phenocrysts: quartz 21.1, alkali feldspar 26.5, plagioclase 41.2, biotite 8.0, opaque minerals 1.1, hornblende 2.1.
11. Tuff of Black Rock Summit at lat 38°29 1/2′ N., long 115°54′ W. Mode count for several samples: 12–25 percent phenocrysts: quartz 8–25, alkali feldspar 0–3, plagioclase 65–70, biotite 7–16, hornblende 0–3, clinopyroxene tr., opaque minerals tr–3.
12. Tuff of Williams Ridge and Morey Peak at lat 38°33′ N., long 116°8′ W. 51.4 percent phenocrysts: quartz 27.3, alkali feldspar 1.5, plagioclase 53.4, biotite 6.5, opaque minerals 0.7, hornblende 2.4, altered mafic minerals 7.8, holes in thin section 0.4.
13. Tuff of Williams Ridge and Morey Peak at lat 38°32′ N., long 116°8′ W. 31.2 percent phenocrysts: quartz 27.9, alkali feldspar 21.8, plagioclase 40.1, biotite 6.5, opaque minerals 0.3, hornblende 3.3, holes within section 1.9.
14. Windous Butte Formation (tuff) at lat 38°45′ N., long 116°20′ W. 38.0 percent phenocrysts: quartz 40.8, alkali feldspar 38.9, plagioclase 19.0, biotite 1.1, opaque minerals 1.3.
15. Windous Butte Formation (tuff) at lat 38°45′ N., long 116° 20′ W. 29.0 percent phenocrysts: quartz 19.1, plagioclase 52.9, biotite 15.2, hornblende 12.2, orthopyroxene 0.7.

and bluish gray, and weathers to brown and buff. In most localities it contains abundant red lithic fragments of Shingle Pass Tuff in its nonwelded to partially welded basal part. It contains 20–35 percent phenocrysts of which quartz constitutes 12–20 percent, alkali feldspar 7–15 percent, plagioclase 45–75 percent, biotite 10–15 percent, hornblende 3 percent, and opaques 2 percent (table 1, samples 5–7). The tuff is everywhere magnetically reversed.

The conclusion that the tuff of Lunar Cuesta was erupted from the Lunar Lake area and that its eruption gave rise to the Lunar Lake caldera is based on three lines of evidence: (1) The thickest known sections of the tuff are adjacent to the Lunar Lake caldera, (2) rhyolite of Big Sand Springs Valley, which is chemically similar to the tuff (fig. 4), rest directly on the tuff of Lunar Cuesta in two sharp scallops (locs. A and B, fig. 3) along the southeastern wall (these rhyolite-scallop-tuff relationships would be extremely unlikely if the caldera formed as a result of either earlier or later tuff eruptions), and (3) the Lunar Lake caldera lies near the center of the area of distribution of the tuff (fig. 5).

The "inferred original" distribution shown in figure 5 encompasses all areas where the tuff is preserved in situ or where its former presence is indicated by [illegible] erosional rubble. The inferred distribution includes areas that have been either deeply eroded or deeply buried but can reasonably be inferred to have been covered by the tuff. For example, the extension of the tuff eastward into Railroad Valley is recognized on the basis of the large thickness preserved along the west flank of the valley. The extension south of the southern Pancake Range beyond the southernmost outcrops is recognized on the basis of evidence there of extensive removal by erosion prior to the eruption of younger tuffs. Such removal is indicated along the east flank of the Pancake Range in the Reveille quadrangle (Ekren, Rogers, and Dixon,



4.—Variation diagrams for samples listed in table 1. All analyses in weight percent recalculated (minus H_2O and CO_2) to 0 percent.

where the tuff thins from 200+ ft (61+ m) to 0 in a ce of less than 3 mi (4.8 km), and there is no indication "lap out" against old topography nor a decrease in the e of welding. If we use the inferred boundaries shown in 5 and assume an average thickness of 200 ft (61 m), the had a volume of approximately 90 mi^3 (370 km^3) and ed nearly 3,000 mi^2 (7,770 km^2).

tuff of Lunar Cuesta is about 25 m.y. old, on the basis Ar analyses of the tuff itself and of samples from over- and underlying strata. Samples of tuff of Lunar Cuesta d on the wall east of Lunar Lake were analyzed by Marvin, who reported (written commun., 1970) dates of 25.5±0.8 m.y. on biotite and 22.5±0.7 m.y. on sanidine. The Shingle Pass Tuff, exposed beneath the tuff of Lunar Cuesta on Palisade Mesa, also yielded dates of 25.5±0.8 m.y. on biotite and 22.5±0.7 m.y. on sanidine. The rhyolite of Big Sand Springs Valley above the tuff of Lunar Cuesta yielded a date of 25.8±3 m.y. on a whole-rock sample; and the tuff of Buckskin Point gave a date of 25.4±1.3 m.y. on biotite.

Chemical variations

Chemical analyses of the principal rocks in the Lunar Lake caldera and the central Nevada caldron complex are shown in table 1, and plots of major oxides against percentage of silica are shown in figure 4. These analyses indicate that no systematic chemical variations took place as eruptions proceeded, starting about 30.5 m.y. ago (approximate age of the Windous Butte) and ending about 25 m.y. ago (approximate age of the tuff of Buckskin Point). The youngest rocks are the most basic as well as the most silicic of the suite (fig. 4). The available analyses indicate that the Windous Butte shows more extreme chemical variations within a single cooling unit than any of the other principal units in the area (compare samples 14 and 15, table 1 and fig. 4). The major oxides of the contrasting lithologies in the Windous Butte, however, all plot neatly along the curves defined by the major oxides of the younger rocks (fig. 4). The Windous Butte is characterized by a mafic-poor rhyolitic base (sample 15) and a mafic-rich quartz latitic top (sample 14). This trend is, in fact, shown by most of the ash-flow tuff cooling units in the Lunar Lake area.

The alkali-lime index for the tuffs and lavas of the Lunar Lake area is approximately 62 (fig. 4). This index is well within the calc-alkalic field of Peacock (1931).

Noble (1972) indicated that most of the lower Miocene volcanic rocks of the Great Basin, particularly those 25–22 m.y. in age, closely resemble the highly differentiated rhyolites found in bimodal basalt-rhyolite provinces. The Shingle Pass Tuff, which separates the younger rocks associated with the Lunar Lake caldera from older rocks of the central Nevada caldron complex, was cited as an example of this type of volcanism. We concur in recognition of the distinctive features of the Shingle Pass Tuff, as well as of the Bates Mountain Tuff and New Pass Tuff, also cited by Noble as examples of "early Miocene silicic volcanic rocks that represent a new pulse of magmatism rather than a continuation of Oligocene calc-alkalic volcanism * * *." Of interest is the close bracketing of the Shingle Pass Tuff in the report area by calc-alkalic volcanism that displays no obvious changes in chemistry or mineralogy.

STRUCTURE AND GEOLOGIC HISTORY OF THE LUNAR LAKE CALDERA

The Lunar Lake caldera is expressed as a partially enclosed topographic basin bounded on the east by an arcuate ridge, The Wall (fig. 2), on the west by Palisade and Halligan Mesas,

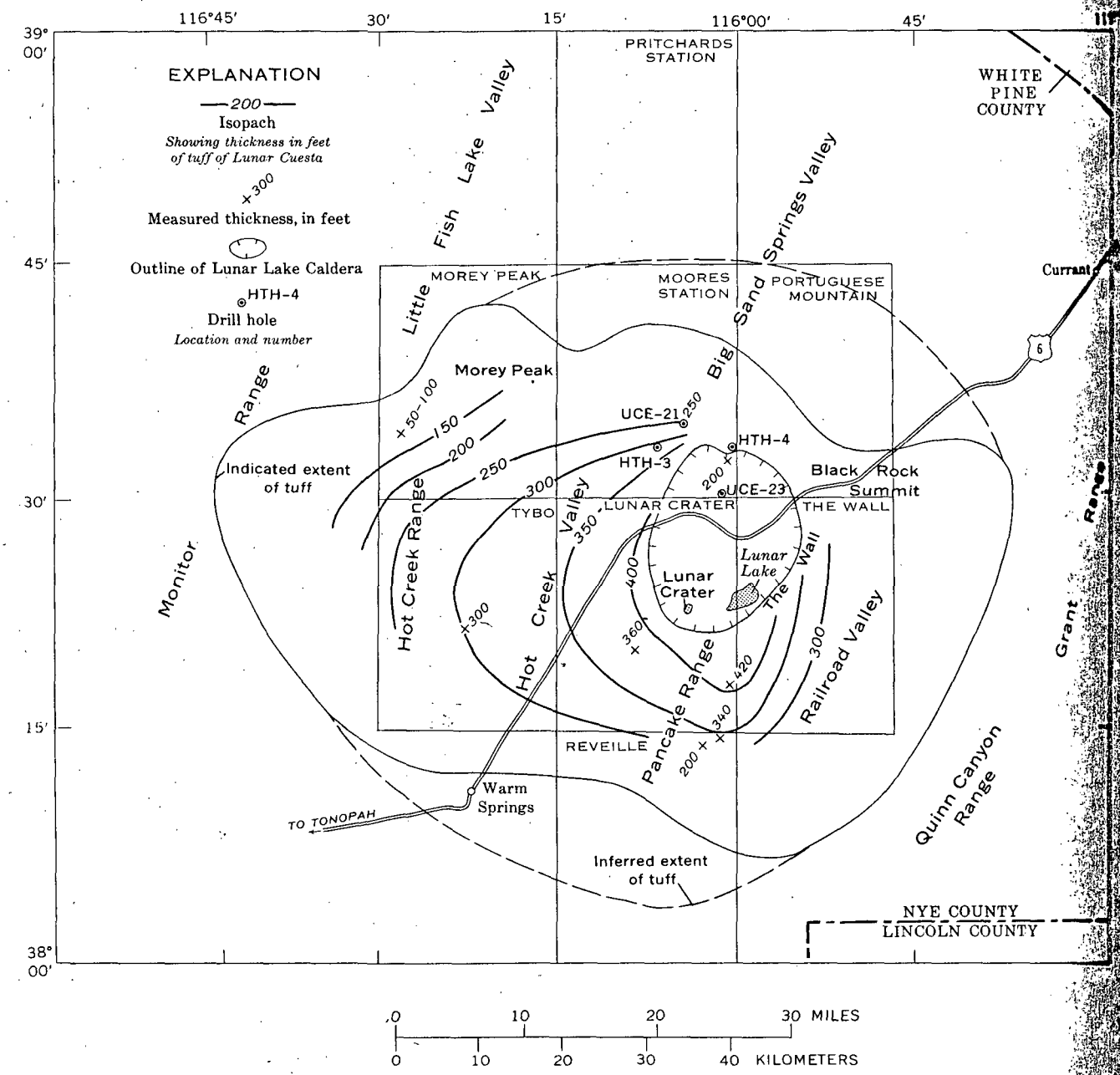


Figure 5.—Sketch map showing quadrangles mapped in central Nevada and showing indicated and inferred original extent of tuff of Lunar Cuesta.

and on the south by Citadel Mountain. On the north side the basin is contiguous with Big Sand Springs Valley. The caldera is best observed from high points along The Wall where a view to the west gives the impression of peering into an enormous kettle filled with bubbling (numerous extinct cinder cones) viscous black liquid (basalt lavas). The boundary of the caldera is well defined only on the eastern and southeastern sides along The Wall. The location of the northern boundary is based on drill-hole and reflection seismic data. The northern boundary was placed south of drill hole HTH-4 (fig. 3) because this drill hole did not penetrate either the tuff of Lunar Cuesta or the Monotony Tuff, which was nearly 1,000 ft (300 m) thick in drill hole UCE-23. Drill hole HTH-4, however, encountered several fault zones; drilling operations were extremely difficult and there was a trememdous loss of drilling fluid. Only two cores were obtained, one from 1,166 ft (355 m) and the other from 6,030 ft (1,840 m). Lithologic correlations (Dixon, Hinrichs, and others, 1974) were made principally on the basis of cuttings and geophysical logs. The possibility exists, therefore, that both the tuff of Lunar Cuesta and the Monotony Tuff were faulted out in this drill hole, and it is problematical whether the caldera wall lies north or south of or, perhaps, ...

the drill-hole location. The occurrence of rhyolite of
nd Springs Valley between depths of about 200 and
(60 and 240 m) indicates that a major fault, probably
nding, lies between the drill hole and the large rhyolite
posed to the northeast (fig. 3). This fault, if it is east-
g as postulated in figure 3, could mark the main caldera
ry or a relatively minor secondary ring-fracture zone.

presumed location of the caldera boundary between
es UCE-21 and UCE-23 is inferred from a reflection
survey run on a traverse line southeastward from
toward UCE-23. The boundary was placed at a point
traverse about 2.5 mi (4 km) southeast of UCE-21 at
utheast edge of a zone of no reflections, which was
ted as a structural high between the Lunar Lake cal-
nd a deeper, older caldron—the "outer Hot Creek Valley
" (Ekren, Hinrichs, and others, 1974). The boundaries
older caldron are not shown in figure 2.
is no present-day indication of western and south-
boundaries to the caldera. This could be due to an
lack of caldera boundary faults along the western half
Lunar Lake depression. Initially, the western half of the
" simply sagged toward the center of the structure.
ild, who mapped part of the Lunar Lake area in 1966,
d that this type of volcanic depression be termed a
or caldron" (written commun., 1972). On the other
the lack of a discernible boundary today may have
from basin-range faulting which effectively lowered
er rim of the caldera (Palisade Mesa) and raised the
(Little Lunar Cuesta). We favor the "trapdoor" inter-
n. That a structural break of some kind exists in this
clearly indicated by the marked contrast between the
flat-lying broad mesas west of Little Lunar Cuesta and
ad depression broken only by the subdued east-tilted
and the abundant cinder cones east of Palisade Mesa.
is structural break may be arcuate in form is suggested
curvilinear nature of the Little Lunar Cuesta fault block

caldera, as just defined, is semicircular in plan, mea-
about 11 mi (18 km) east to west, and 13 mi (21 km)
south. Owing to the effect of postcaldera basin-and-
ulting, the amount of vertical displacement is difficult
mine in the caldera. Drill hole UCE-23, for example,
ted the tuff of Lunar Cuesta at a depth of 1,200 ft
) and an elevation of 4,600 ft (1,400 m), which is
2,000 ft (610 m) lower than the top of the tuff in the
outcrop outside the caldera. This 2,000 ft (610 m) of
al relief may be due partly to caldera displacement and
o basin-and-range faulting, or it may constitute the
al relief remaining after the drill-hole area was rela-
uplifted by basin-and-range faulting. The first possibility
more plausible, however, and a minimum of about
(305 m) and a maximum of about 2,000 ft (610 m)
acement for the central part of the Lunar Lake caldera
y are a reasonable estimate.

Drill hole UCE-23 cut a basalt flow intercalated in alluvium at a depth of 140–175 ft (43–53 m), continued in alluvium to a depth of about 1,100 ft (335 m); from 1,100 ft (335 m) to 1,200 ft (365 m) it cut 100 ft (30 m) of bedded tuff and debris; it penetrated intensely fractured (probably faulted) tuff of Lunar Cuesta between 1,200 and 1,240 ft (365 and 380 m). The total thickness of the tuff of Lunar Cuesta cut by the drill hole, determined from cuttings and geophysical logs, is 200–350 ft (61–105 m), which indicates that the tuff is no thicker in the caldera than outside; conceivably it is thinner. Eruption of the tuff of Lunar Cuesta, therefore, apparently was completed before caldera subsidence began. In this regard, the Lunar Lake caldera is similar to the Valles caldera of New Mexico where the last erupted tuff is no thicker inside the caldera than outside (Smith and Bailey, 1968), and it differs from the Timber Mountain caldera in southern Nevada (Byers and others, 1969) and many other calderas where subsidence and tuff eruptions occurred concurrently.

The relationship of the Lunar Lake caldera with older caldrons within the large multiple-caldron complex (fig. 2) indicates that it was the last caldera to form and, although nested within the central complex, its boundaries overlap and partly coincide with boundaries of older caldrons. The proximity of the buried northern wall to the wall of the "outer Hot Creek Valley caldron" (Ekren, Hinrichs, and others, 1974), as indicated by a reflection seismic survey, has been previously described. That an earlier caldron wall existed approximately at the present-day well-defined eastern wall of the Lunar Lake caldera is strongly suggested by the unconformable relationships of the Monotony Tuff where it rides up against a northeast-trending topographic high formed of pre-Monotony quartz latite lava (loc. A, fig. 3) and against the tuff of Black Rock Summit and the tuff of Palisade Mesa (figs. 3, 5) in exposures south of Black Rock Summit. This older wall could have formed during a period of subsidence related to the extrusion of the tuff of Palisade Mesa or the tuff of Halligan Mesa, or both. If this is so, the data from drill hole UCE-23 indicate that younger rocks, principally the voluminous Monotony Tuff, filled the caldera prior to the eruption of the tuff of Lunar Cuesta. The possibility also exists that the drill hole lies within the caldera which formed as a result of Monotony Tuff eruptions.

On Palisade Mesa, the northeast-trending fault that extends through the mesa (against which the Shingle Pass Tuff was deposited and over which the tuff of Lunar Cuesta was deposited) is inferred to be the western wall or boundary of the caldera that formed as a result of the extrusions of the widespread Monotony Tuff. This caldera is truncated by the Lunar Lake caldera in the vicinity of Lunar Cuesta, and its northern boundary is concealed within the Lunar Lake caldera. Farther south, in the Reveille quadrangle (Ekren, Rogers, and Dixon, 1974), the caldera is cut by a system of northwest-trending left-lateral faults, and the southwestern part of the caldera is strung out as a series of fault slices along splays of the left-lateral system (Ekren, Rogers, and Dixon, 1974).

CHRONOLOGY OF VOLCANIC EVENTS

1. Tuff eruptions and the development of a multiple-caldera complex started in central Nevada about 30–31 m.y. ago with the eruption of the Windous Butte Formation and related rocks.
2. For a period of 3–4 m.y. tuff eruptions continued and numerous calderas were formed within the caldron complex. About 25 m.y. ago the tuff of Lunar Cuesta was erupted from vents located in the southeastern part of the caldron complex. The eruption of this tuff, having a volume of about 90 mi^3 (375 km^3), resulted in the collapse of a semicircular area about 12 mi (19 km) in diameter and possibly 1,000–2,000 ft (305–610 m) deep—the herein-named Lunar Lake caldera.
3. Rhyolite lavas were erupted from the northern and southeastern ring-fracture zones of the Lunar Lake caldera.
4. The tuff of Buckskin Point, quartz latite and andesitic lavas, and the tuffs of Buckwheat Rim and Black Beauty Mesa were erupted from fissures in the vicinity of Citadel Mountain. These eruptions did not result in caldera development.
5. The caldera was broken by basin-and-range faults, and two fault blocks were uplifted relative to the remainder of the caldera to form Lunar and Little Lunar Cuestas.
6. In Quaternary time basalt lavas and pyroclastic debris were erupted from a northeast-trending fissure system that extends through the Lunar Lake caldera and coincides, in part, with the old fissure system that extends through the Citadel Mountain area.

REFERENCES CITED

Anderson, R. E., 1970, Ash-flow tuffs of Precambrian age in southeast Missouri: Missouri Div. Geol. Survey and Water Resources Rept. Inv. 46, 50 p.

Byers, F. M., Jr., Carr, W. J., and Orkild, P. P., 1969, Volcano-tectonic history of southwestern Nevada caldera complex, U.S.A. [abs.] *in* Symposium on volcanoes and their roots: Oxford, England, Internat. Assoc. Volcanology and Chemistry of the Earth's Interior, v. abs., p. 84–86.

Cook, E. F., 1965, Stratigraphy of Tertiary volcanic rocks in eastern Nevada: Nevada Bur. Mines Rept. 11, 61 p.

Ekren, E. B., Anderson, R. E., Rogers, C. L., and Noble, D. C., 1971, Geology of northern Nellis Air Force Base Bombing and Gunnery Range, Nye County, Nevada: U.S. Geol. Survey Prof. Paper 651, 91 p.

Ekren, E. B., Bath, G. D., Dixon, G. L., Healey, D. L. and [illegible] W. D., 1974, Tertiary history of Little Fish Lake V[illegible] County, Nevada, and implications as to the origin of the Basin: U.S. Geol. Survey Jour. Research, v. 2, no. 1, p. 16[illegible]

Ekren, E. B., Hinrichs, E. N., and Dixon, G. L., 1973, Geology of The Wall quadrangle, Nye County, Nevada: U.S. Geol. Survey Geol. Inv. Map I-719, scale 1:48,000.

Ekren, E. B., Hinrichs, E. N., Quinlivan, W. D., and Hoover, [illegible] 1974, Geologic map of the Moores Station quadrangle, [illegible] County, Nevada: U.S. Geol. Survey Misc. Geol. Inv. Map [illegible] scale 1:48,000.

Ekren, E. B., Rogers, C. L., and Dixon, G. L., 1974, Geology and Bouguer gravity map of the Reveille quadrangle, Nye County, Nevada: U.S. Geol. Survey Misc. Geol. Inv. Map I-[illegible] 1:48,000. (In press.)

Gromme, C. S., McKee, E. H., and Blake, M. C., Jr., 1972, Paleomagnetic correlations and potassium-argon dating of middle Tertiary ash-flow sheets in the eastern Great Basin, Nevada and Utah: Geol. Soc. America Bull., v. 83, p. 1619–1638.

Hoover, D. L., 1964, Flow structures in a welded tuff, Nye County, Nevada [abs.], *in* Abstracts for 1963: Geol. Soc. America Special Paper 76, p. 83.

Noble, D. C., 1972, Some observations on the Cenozoic volcano-tectonic evolution of the Great Basin, western United States: Earth and Planetary Sci. Letters, v. 17, p. 142–150.

Peacock, M. A., 1931, Classification of igneous rock [illegible] Geology, v. 39, no. 1, p. 54–67.

Quinlivan, W. D., and Rogers, C. L., 1974, Geologic map of the [illegible] quadrangle, Nye County, Nevada: U.S. Geol. Survey Misc. Geol. Inv. Map I-821, scale 1:48,000. (In press.)

Quinlivan, W. D., Rogers, C. L., and Dodge, H. W., Jr., 1974, Geologic map of the Portuguese Mountain quadrangle, Nye County, Nevada: U.S. Geol. Survey Misc. Geol. Inv. Map I-804, scale 1:48,000. (In press.)

Sargent, K. A., and Houser, F. N., 1970, The Shingle Pass [illegible] central Nevada: Geol. Soc. America Abs. with Programs (Cordilleran sec.), v. 2 no. 2, p. 140–141.

Scott, D. H., and Trask, N. J., 1971, Geology of the Lunar Crater volcanic field, Nye County, Nevada: U.S. Geol. Survey Prof. Paper 599-I, 22 p.

Smith, R. L., and Bailey, R. A., 1968, Resurgent caldrons, *in* Coats, R., Hay, R. L., and Anderson, C. A., eds., Studies in volcanology—a memoir in honor of Howel Williams: Geol. Soc. America Mem. 116, p. 613–662.

Snyder, R. P., Ekren, E. B., and Dixon, G. L., 1972, Geologic map of the Lunar Crater quadrangle, Nye County, Nevada: U.S. Geol. Survey Misc. Geol. Inv. Map I-700, scale 1:48,000.

U.S. Geological Survey, 1970, Geological Survey research 1970: U.S. Geol. Survey Prof. Paper 700-A, 426 p.

Walker, G. W., and Swanson, D. A., 1968, Laminar flowage in Pliocene soda rhyolite ash-flow tuff, Lake and Harney Counties, Oregon, *in* Geological Survey research 1968: U.S. Geol. Survey Prof. Paper 600-B, p. B37–B47.

Northern Nye Co.

UNIVERSITY OF NEVADA BULLETIN

VOL. XLV JANUARY 1951 No. 3

GEOLOGY AND MINING SERIES No. 50

MINERAL RESOURCES OF NYE COUNTY, NEVADA

By
VICTOR E. KRAL
Mining Engineer

PRICE ONE DOLLAR

PUBLICATION OF THE NEVADA STATE BUREAU OF MINES
AND THE MACKAY SCHOOL OF MINES
JAY A. CARPENTER, *Director*

1:6

PUBLISHED QUARTERLY BY THE
UNIVERSITY OF NEVADA
RENO, NEVADA

Entered in the Post Office at Reno, Nevada, as second-class matter under Act of Congress, July 16, 1894. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized April 21, 1919.

STATE PRINTING OFFICE OF NEVADA — JACK McCARTHY, SUPERINTENDENT
CARSON CITY

TABLE OF CONTENTS

ILLUSTRATIONS

Maps in Pocket

PREFACE

This bulletin on the "Mineral Resources of Nye County" is the third to be issued by the Nevada State Bureau of Mines, it being preceded by the "Mineral Resources of Douglas, Ormsby, and Washoe Counties," and the "Mineral Resources of Storey and Lyon Counties."

The Bureau has been fortunate in obtaining the services of Victor E. Kral, a Mackay School of Mines graduate of 1938, as the mining engineer to prepare this bulletin.

From 1939 to 1942, he was the instructor of the traveling school for prospectors of the Nevada Department of Vocational Education. From 1942 to 1944, he was with the War Department examining mining properties in the Tonopah Bombing Range, and to 1946 with the U. S. Bureau of Mines as a field engineer along with the preparation of six "Reports of Investigations" on Nevada mines.

His thoroughness, his willingness to give information and aid to all, and his pleasing personality are all hereby gratefully acknowledged.

The first summary of all the State's mineral resources to be published was the "Mining Districts and Mineral Resources of Nevada" by Francis Church Lincoln in 1923. This was prepared by him while Director of the Mackay School of Mines of the University of Nevada and before the Nevada State Bureau of Mines came into existence in 1929. The Bureau has since distributed this authoritative 300-page book to a very appreciative public. Naturally, the treatment of each mining district was restricted to a short statement, but accompanied by an excellent bibliography.

In the '30's the United States Bureau of Mines started a study of the State as to the mining activities in each county. This work was carried out by William O. Vanderburg, and before this work was discontinued, by war necessity, there had been issued as information circulars, the "Reconnaissance of Mining Districts in Churchill County," I. C. 7093; "in Clark County," I. C. 6964; "in Eureka County," I. C. 7022; "in Humboldt County," I. C. 6995; "in Lander County," I. C. 7043; "in Mineral County," I. C. 6941; and "in Pershing County," I. C. 6902, or seven in all. While these reports covered only the active mines in those counties at that time, they have proved to be of great value to our Bureau and to

the mining fraternity. They are now practically out of print, but our Bureau secured a few extra copies for loan purposes.

As Lincoln's figures on the gross value of the metal production from counties, districts, and mines was not accurate, our Bureau in 1943 issued a bulletin prepared by Mr. B. F. Couch, its secretary, giving this production data as taken from the tax statements required in the State since its early Statehood days.

By 1943 the geological bibliography in Lincoln's book was two decades in the past, therefore, in 1945 the Bureau issued a very complete combined, Bibliography of Geologic Literature by Vincent P. Gianella and Bibliography of Geologic Maps of Nevada Areas by Robert W. Prince.

In 1945 began the study to check more thoroughly on the early history of Nevada mining districts than given in Lincoln's book and to cover the interesting time since its publication, with the plan to issue county bulletins, covering first those counties not covered by the United States Bureau of Mines Information Circulars.

In planning to make such an exhaustive search of mining literature on Nevada it was evident that for efficiency this data should be collected for all the counties at the same time. This entailed many long months of preparation before the writing of the first bulletin could be undertaken.

Particular attention was paid to finding and listing all technical articles published on Nevada mining since Lincoln's bibliography, and to consulting the Bureau's index and clipping file of mining news from Nevada newspapers, as the history of many mining properties can only be found therein.

This accumulated data, including United States Government and private reports, has been classified into county and district files, and while all this material cannot be included in the bulletins, reference is made to it, and it is readily available to all who may call at our office, thus avoiding a long and tedious search on their part. It also enables the Bureau to quickly obtain the information requested by correspondence.

In writing this bulletin a special effort has been made to give data on idle properties that have been neglected or forgotten, and to give the names of engineers and of individuals who now have knowledge of or own them, in order to expedite the work of those seeking Nevada mining properties.

The accompanying maps were chosen and secured through the

courtesy of the State Highway Department because of the inclusion of so much engineering data, including roads and land subdivisions, to which has been added the location of the mining districts of the counties.

As most of these districts have no definite boundaries, their general locations are simply shown as small circles on the maps. Properties between districts are described with the closest one. Often two or more names are in common use for the same district and are so shown.

Mining districts existed before Nevada became a State. The miners met and defined the limits of the district, made regulations, and appointed a recorder for the claims located. The State laws made no provision for legalizing such action nor for filing such information with the State, but only define the duties of the recorder. It would be presumed then that the counties by commissioner action would regulate the formation of districts and require copies of the organization proceedings and the election of recorders to be filed at the county court house. Inquiry of county officers, and a search of the list of all county records of Nye County made by the Historical Records Survey of the W. P. A., failed to find any such official information.

The United States Geological Survey issued a map in 1907 showing the mining districts in the West, and in 1912 issued Bulletin 507 on "The Mining Districts of the Western United States." This bulletin states: "for many districts these (district) limits are uncertain and vague and cannot always be ascertained, though the data are supposed to be on file with the county authorities."

The U. S. Government has no record of claims until patent is applied for. In the application the survey location is given with the name of the district. The latter is not checked, but the Public Survey Office in Reno issued a map locating districts based upon that uncertain information. This varies greatly from that of Lincoln's "Mining Districts and Mineral Resouces of Nevada."

The State law provides that claim locations shall also be filed with the County Recorder, and with the present easier and faster means of travel of mail and persons, the older mining districts, with one or two exceptions, apparently no longer have duly elected recorders, and newer districts are seldom organized, for a new discovery. For convenience the term district is used and named after the locality or the mine.

The only advantage of segregating claims into districts named

after localities is the ease of finding the same on maps or in the field.

The gelogical descriptions in this bulletin are based, in great part, upon publications and maps of the United States Geological Survey, too numerous to mention individually.

The two best general references are the Bureau's two publications, Mining Districts and Mineral Resources of Nevada, by Francis Church Lincoln, and Bibliography of Geologic Literature of Nevada, by Vincent P. Gianella, with the Bibliography of Geologic Maps of Nevada Areas, by Robert W. Prince.

JAY A. CARPENTER,
Director, Nevada State Bureau of Mines.

ACKNOWLEDGEMENTS AND REFERENCES

My acknowledgements and thanks go to the large number who have in one way or another aided in the gathering of information and the writing of this bulletin. In the field work, the property owners and prospectors themselves have aided the most. Much information was obtained from reports and notes in the files of engineers and other interested parties; this, whenever possible, was tied in with information obtained in the field.

Director Carpenter, with his years of experience in Nevada during which he visited, examined, and operated mines in many Nye County mining districts, aided greatly by supplementing and checking information obtained from other sources. Mr. Carpenter also did all the critical reading, which the writer believes was exceptionally well done.

The staff of the Mackay School of Mines have all aided in the preparation of this bulletin. The geology department in particular was often called upon, and special mention is due Director Walter S. Palmer and his assistant, Claude W. Hammond of the State Analytical Laboratory for analytical and mineral determinative work done.

Most writers and their publications which were used are mentioned in the text or in footnotes; however, a few publications are used so frequently that the writer's name alone is mentioned. These are as follows:

Couch, Bertrand F., Nevada's Metal and Mineral Production: Nevada State Bureau of Mines, Vol. XXXVII, No. 4, 1943. (This is supplemented by later unpublished figures from Mr. Couch.)

Lincoln, F. C., Mining Districts and Mineral Resources of Nevada; Nevada Newsletter Publishing Company, 1923.

Bailey, E. H. and Phoenix, David A., Quicksilver Deposits in Nevada: Nevada Bureau of Mines, Vol. XXXVIII, No. 5, 1944.

Ball, Sydney H., A Geologic Reconnaissance in Southwestern Nevada and Eastern California: U. S. Geological Survey Bull. 308, 1907.

Raymond, R. W., Statistics of Mines and Mining in States and Territories West of the Rocky Mountains: (Year of publication given in reference.): U. S. Government Printing Office, Washington, D. C.

Thompson and West, publishers of History of Nevada, 1881.

Very frequent use was also made of:

Mineral Resources: U. S. Geological Survey.

Minerals Yearbook: U. S. Bureau of Mines.

Gianella, V. P., Prince, R. W., Bibliography of Geologic Literature of Nevada, and Bibliography of Geologic Maps of Nevada Areas: Nevada State Bureau of Mines, Vol. XXXIX, No. 6, 1945.

All references to bulletins prepared by the Nevada State Bureau of Mines are made to volume and number of the University of Nevada bulletins.

VICTOR E. KRAL.

MINERAL RESOURCES OF NYE COUNTY, NEVADA

NYE COUNTY

History. The bill establishing Nye County was approved by the Nevada Territorial Legislature and Governor on February 16, 1864.[1]

The county was named for Governor J. W. Nye, the appointed governor of the Territory. Nye County was formed from Esmeralda County which, prior to this time, included that part of Nevada south of the 39th parallel and east of Mason Valley. After the new county was formed several changes were made in its boundaries. In 1866 the southeastern part was formed into Lincoln County. In 1869 and 1875, parts along the east side were added to Lincoln and White Pine Counties.

The county was formed as a result of a petition by the miners of the Union district who stated that they were too far removed from Austin in Lander County and Aurora in Esmeralda County. The legislative committee reporting on the bill stated that the proposed county had a population of 1,000 to 1,500.

Ione was designated as the first county seat. On May 15, 1867, the county seat was moved to Belmont where it remained until 1905[2] when it was moved to Tonopah which had been booming for several years and was now a sizeable community.

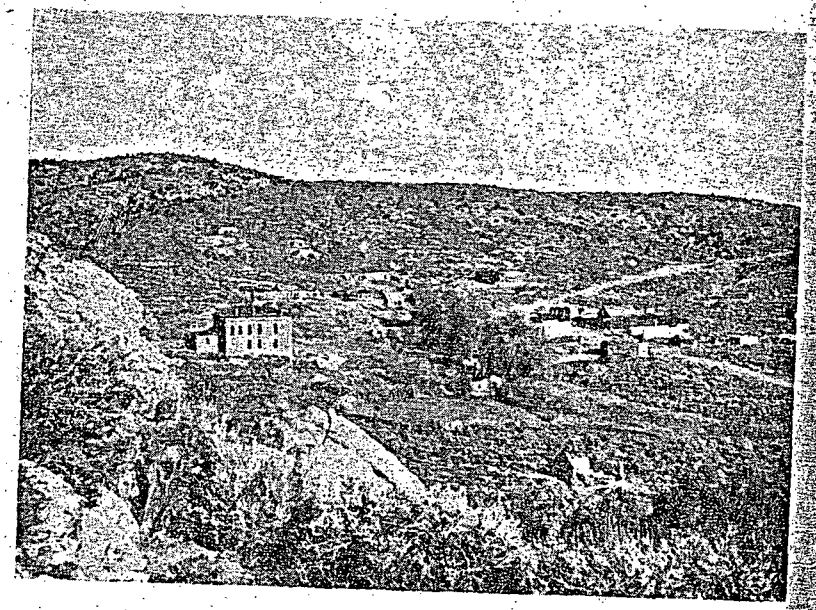
Nye County has an area of 17,376 square miles which is approximately one-sixth that of Nevada. It is the third largest county in the United States, the greatest distance across it, from southeast to northwest, being about 240 miles air line.

It is not known when the earliest prospectors made their way into the area later designated as Nye County, however, it is known that the early sixties saw much activity in the Union and Mammoth mining districts which were discovered in 1863. The San Antone district was discovered the same year by a party of Mexicans.

As Austin was the source of supply for all of central Nevada, and the rush to this new camp took place in 1862, it may be assumed that prospecting in the area to the south began about that year. The Stone Cabin Ranch, situated between the Monitor and Hot Creek Ranges and north of the Tonopah-Ely highway,

[1] All historic data taken from Thompson & West.

[2] Nevada Highways and Parks, Vol. X, No. 2, p. 6, April-July, 1950.



(1) Camps whose mining activity is now hardly more than a memory.
Upper. Belmont with its historic courthouse.
Lower. Murphy Mine, Ophir Canyon. The ruins of a $250,000 reduction plant.

as related by Mr. Joe Clifford, was settled by his father about this time. In later years the elder Clifford and his sons had much to do with mineral discoveries in this part of the county.

Captain John Fremont's[3] expedition of 1845 took him south through the Big Smoky Valley and westerly around the south end of the Toiyabe (Toyabe) Range to Walker Lake. This was strictly an expedition and had little or no bearing on mineral discoveries. Furthermore, the group did not tarry as it required only 3 days travel between Darrough's Hot Springs and Walker Lake.

As to mineral development prior to 1862, some mention has been made of earlier activity. Mr. Clifford of Stone Cabin reports he has found apparent evidence that Mexicans mined in the San Antone district in about 1854. Mr. Noel Phillips of Fallon reports that he has found an unusually large percentage of French names in an old store ledger used in Ellsworth. He believes this indicates that the early trappers of Canada came this far south and, if so, may have been here well before the sixties.

Topography. Elevations and, therefore, general climatic conditions vary tremendously between the northern and southern parts of the county. In the north the peaks of the ranges vary from 8,000 feet to over 11,000 feet altitude, and the valley elevations are at about 5,000 to 6,500 feet altitude. Elevations in the most southern part, in Pahrump Valley, drop to about 2,000 feet.

Nye County topography is typical of the Great Basin; a series of north-south ranges with valleys between that drain to sinks and alkali flats. In the northern part of the county the principal ranges from west to east are as follows:

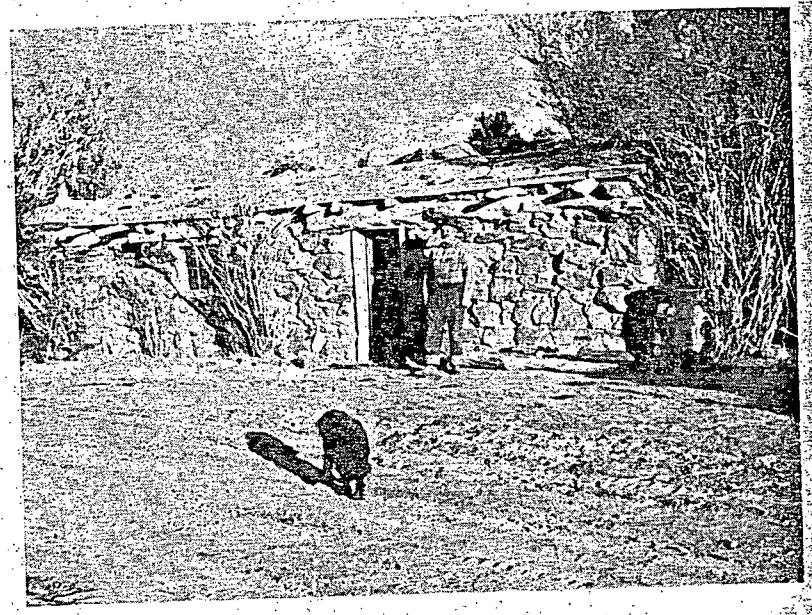
The Paradise Range, with Sherman Peak rising to 8,657 feet, has the magnesite and brucite producing community of Gabbs on its west flank. The continuation of these mountains to the north is the Desatoya Range.

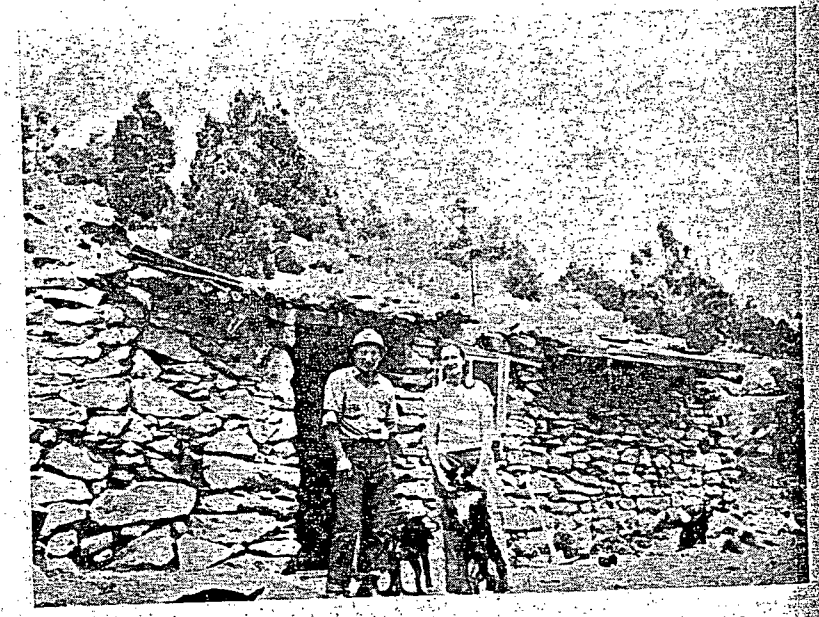
The Shoshone Range, rising to 10,072 feet in South Shoshone Peak, has the Union district with the town of Ione and the lead-silver camp of Grantsville.

East of this is the narrow Reese River Valley and the Toiyabe (Toyabe) Range which rises to 11,775 feet at Arc Dome.

Next is the Big Smoky Valley and the Toquima Range which rises to several peaks, the highest of which is Mount Jefferson at 11,807 feet. The town of Round Mountain with the large dredging operation and Manhattan are on the west flank and the old county seat of Belmont is on the east flank. To the south this

[3] Mack, Effie, M., Nevada: A. H. Clark Co. pp. 100-01, 1935.





(2) Native stone was a common early day building material.
Upper. Joe Clifford and one of the stone cabins. This is one of the original buildings of the landmark, the construction of which began about 1862.
Lower. Mr. and Mrs. Jack Ekstrom and their comfortable stone house in the Danville district.

range develops into the San Antonio Range with Tonopah in the southern portion.

Across the wide Monitor Valley the Monitor Range is next east. It rises to over 10,000 feet and is wider than the previously mentioned mountains.

Next east is the Hot Creek Range with the Little Fish Lake Valley, the floor of which is over 6,000 feet elevation, on its west. The camp of Tybo is the largest producer here. To the south this is known as the Kawich Range which continues into the southern part of the county east of Beatty. The Kawich Range has the old camps of Bellehelen, Golden Arrow, Silver Bow, and Kawich.

The Pancake Range which rises only slightly over 8,000 feet is next east. It has had very little mining activity. To the south this develops into the Reveille and then the Belted Range with the old camp of Reveille and, near the south end of the Belted Range, the Oaks Springs district.

The Grant Range, the southern part of which is known as the Quinn Canyon Range, is the farthest east of the larger mountains of Nye County. To the south this also develops into the Belted Range. The old camp of Troy and the Willow Creek district are on the west flank of the range. Elevations are high here with Troy Peak rising to 11,268 feet altitude.

The Cactus Range in the southern part of Nye County is set off by itself and has no apparent connection with other mountains in the area. It lies east of Goldfield and on its flanks are the districts of Cactus Springs, Antelope Springs, Wellington, Wilsons, and Trapmans.

General Geology. Geologically the mountain ranges in the northern part of the State are largely Mesozoic and Paleozoic sediments with some meta-volcanics. Mesozoic formations are more common in the western ranges, and the rocks of the central and eastern ranges are largely of the Paleozoic era. Tertiary volcanic flows are common at the lower elevations on the flanks of the ranges, and Tertiary intrusives are found widely distributed. Granitics of Jurassic and Cretaceous age have intruded the older rocks in all areas.

The youngest sediments are lake beds of upper Miocene age, commonly referred to as "Siebert Lake beds" and now known to be part of the Esmeralda formation.[4] These young sediments are sometimes overlain comformably by rhyolitic lava flows and these by Pliocene andesite lavas.

[4]Ferguson, H. G., The Mining Districts of Nevada: Nevada State Bureau of Mines, Vol. XXXVII, No. 4, pp. 90-91, 1944.

In the southern part of the county the Tertiary volcanics are much more common and cover more of the area. Some basalts here may be as young as Pleistocene. The older sediments are also exposed here and are largely of the Paleozoic era. A few granitic intrusives of Eocene(?) age are found in the older rocks. The formations in this region are well described by Ball and his geologic map of the full area gives a ready picture of the general geology.

The mineral deposits are found in both the younger volcanics and the older sediments. The gold and silver mines found in the volcanics, with Tonopah as the best example, have been the most important producers. The magnesite-brucite deposits in the Triassic dolomites of the Paradise Range have already proven to be important and will probably become more so as time goes on. An impressive gold producer from Tertiary rhyolite is the Round Mountain district, and with the present large-scale dredging operation of the placer from this auriferous rhyolite, it will prove to be a major source of the Nye County gold production.

Mining Districts. Lincoln's "Mining Districts and Mineral Resources of Nevada," published in 1923, listed 51 mining districts in Nevada. In 1945 Gianella's "Bibliography of Geologic Literature of Nevada" used the same list of districts as given by Lincoln and added three which had come into use since Lincoln's tabulation. These districts were Paradise Range, in the vicinity of Gabbs; Quartz Mountain, in the northwest part of the county, and Wahmonie, in the southern part of the county, northeast of Lathrop Wells.

This publication describes 52 mining districts in Nye County. Seven districts listed by Gianella are included with adjoining districts, two are separated from larger districts because of topographic separations, and three new districts are listed.

Improved transporation facilities have in a sense decreased distances, therefore, two or more smaller adjoining mining districts are here often described together. This is particularly so if the areas are topographically and geologically similar. The consolidated districts are Black Spring which is included with Cloverdale, Butterfield Marsh with Currant, Carrara and Lee with Fluorine, Millett with Twin River, Paradise Range with Mammoth, and Quartz Mountain with Lodi.

Of the five added districts, two are separated from other districts because they are in different mountain ranges and are commonly referred to by the mining fraternity under individual names. The Mammoth district is separated from the Lodi as it includes a large part of the Paradise Range, and the Lodi district is here described as including only the Lodi Hills. The Royston district is not included in the San Antone as the two are separated by the Big Smoky Valley.

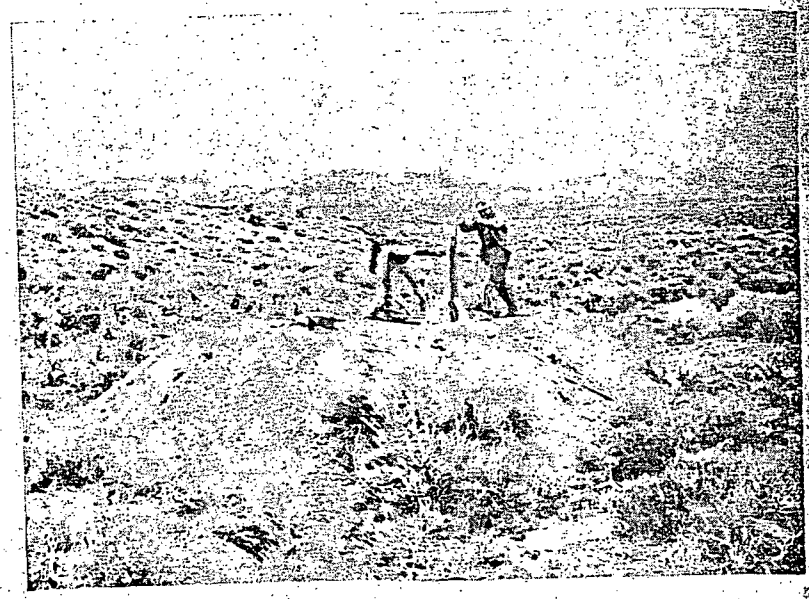
Three new districts are added because the mining activity in the areas involved is too far from older known districts to be embraced by them. The Goldfield mining district is added to include that part of the Esmeralda County activity overlapping into Nye County. The Longstreet district is named for the Longstreet mine to include much of the southern part of the Monitor Range. Mellan Mountain, although not believed previously mentioned in written descriptions of the Cactus Flat area, has been commonly referred to by that name for many years. It includes a small area of much mining activity east of the Cactus Range. For the convenience of the reader all district names, both old and new, are included in the table of contents.

Tonopah Bombing and Gunnery Range. In October 1940 a large area in the southern part of the State, principally in Nye County, was withdrawn from further mineral entry and designated as the Tonopah Bombing and Gunnery Range. Immediately after the entry of the United States into World War II, the area was closed, even to travel, and the Air Force began training here.

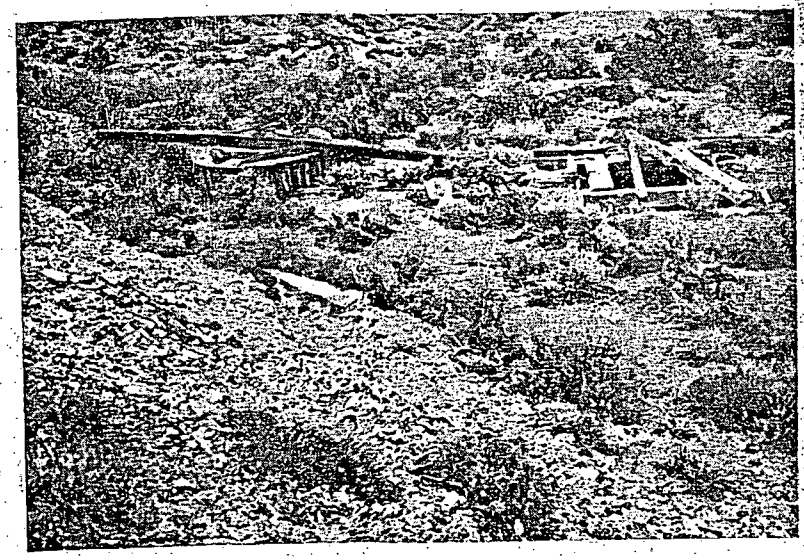
All mining properties within the Tonopah Bombing and Gunnery Range were originally leased to the government for a period of 5 years and these leases have been renewed. At present the original claim owners still retain title to their claim rights but are not required to perform annual assessment work as they may not trespass on the Range. The present area of that part of the Tonopah Bombing and Gunnery Range in Nye County represents approximately one-fifth the area of the county. The approximate present boundaries of the Range are shown on Maps 6, 7, and 8.

The following Nye County mining districts are either all or partly within the present boundaries of the Tonopah Bombing and Gunnery Range: Antelope Springs, Cactus Springs, Gold Crater, Goldfield, Kawich, Mellan Mountain, Oak Spring, Wahmonie, Wellington, and Wilsons.

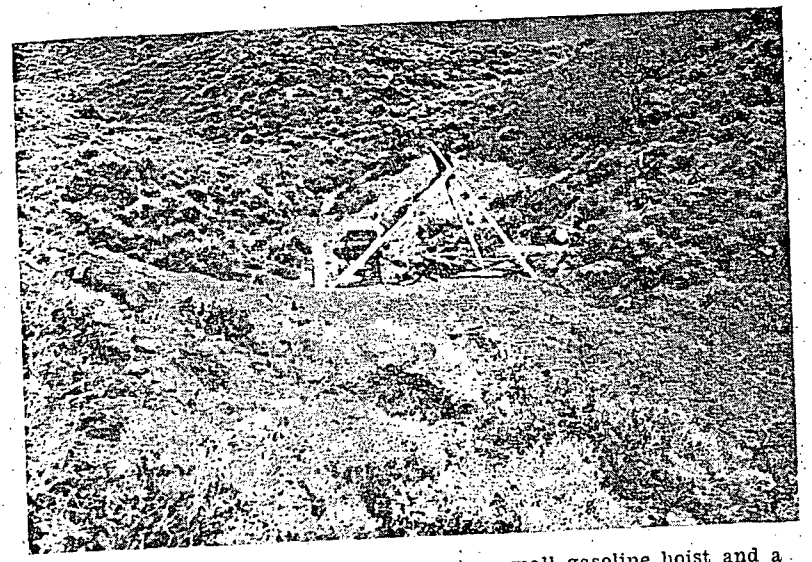
Future of Nye County Mining. As has just been mentioned, two deposits in the county are at the beginning of what is anticipated to be long productive periods; otherwise the general mining outlook is usually considered to be poor; however, progress is dependent on new exploration and the future may well see production equal to that of the past.



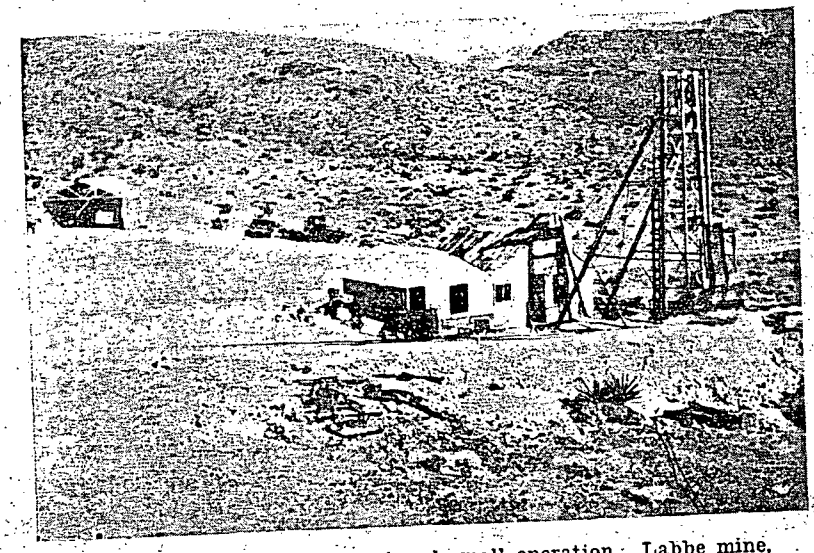
(3) Exploration by hand. A two-man windlass hoisting from a 90-foot depth in placer exploration near Ione.



(4) The remains of a horse whim at one of the old shafts of the Gila mine, Old Reveille.



(5) Typical small scale exploration using small gasoline hoist and a compressor converted from a Model A Ford.



(6) Final step in a well-equipped small operation. Labbe mine, Johnnie district. (C. H. Labbe)

The period of the rushes and the booms is probably gone but production developed from the careful use of all modern exploration techniques has yet to get a good start. Today we have faster, and possibly better, methods of geologic mapping; aided by aerial photography (including color), better roads, and more versatile means of transportation. We are just beginning to make use of geophysical surveys integrated with other geologic mapping.

For the actual physical exploration, machinery today has been designed to give better and faster results with less weight and less cost of operation. Diamond drills are lighter and more mobile; bits are precast, allowing the use of cheaper stones and making the over-all cost lower. Small rotary drilling rigs are coming into the same fields occupied by diamond drills and churn drills. Roads are better and there are more of them, also, small road building tractors make it possible to take exploration equipment to places formerly considered inaccessible. Compressors are mounted on rubber-tired wheels for greater mobility and in some cases are made as an integral part of small tractors to aid in the building of roads.

Exploration equipment is now so readily moved that many formerly productive mines can have additional exploration more easily done. Favorable unexplored sections of the vein or the walls may be quickly probed for new ore bodies. Many mines filled with water only have a low or moderate water flow that, with modern portable electrical generating equipment and electric pumps, can be unwatered with speed and efficiency.

Geophysical exploration, coupled with geologic mapping of many of our "worked out" sulfide ore deposits, can give us a tremendous amount of information at relatively low cost. Favorable areas may then be physically explored.

These advances in exploration techniques which help mining are in use today, but not generally so. When we finally make use of all our facilities to find new ore deposits, the production of Nye County as well as many other areas will increase rapidly.

It appears that the underlying necessities to any future exploration program are good geologic maps of the mining districts. To date only a small fraction have been mapped and the sooner this work is completed the sooner we may expect the next steps in the search for our hidden mineral wealth to gain momentum.

Changes in mining and metallurgical techniques will in the future, as they have in the past, make many marginal mineral deposits worthwhile to mine. The increased efficiency of surface mining methods, with their low cost, have already resulted in many new mining operations in the State. Also, in the field of nonmetallics, deposits of now worthless material are very apt to become marketable as time goes on.

The excitement of oil exploration has recently struck Nevada and has caused considerable lease speculation. Although only a minor area has been leased in Nye County, the heaviest leasing being in the counties to the north and east and in the southern part of the State, exploratory drilling is now being conducted in White Pine County only 9 miles from its boundary with Nye County. As of October 1950, about 2 million acres of Government land in Nevada had been leased for oil and gas. Although this interest in the search for oil in Nevada is a great help to the State, needless to say, the finding of oil would be a tremendous benefit to all of the State as well as to the individual counties involved.

MINING DISTRICTS

ANTELOPE SPRINGS

The Antelope Springs mining district lies on the east slope of the Cactus Range near the southeastern end of the main part of the range. It is about 30 miles southeast of Goldfield and is all within the Tonopah Bombing and Gunnery Range.

Antelope Springs, for which the district was named, furnish sufficient water for camp purposes and it is believed that enough water for milling could be obtained by drilling wells.

The district is well described by F. C. Schrader.[5] He states that gold was discovered here in 1903 by the Bailey brothers of Cactus Springs. In November 1911, Jordan and Reilly discovered high-grade gold ore and soon about 150 men were prospecting the immediate area. Shrader states:

> By the close of the year a $15,000 five-day option had been taken on the Antelope View claim (Jordan & Reilly) by George Wingfield of the Goldfield Consolidated Mines Company, who prosecuted the work of sinking a shaft continuously with good results, but as he wished a brief extension of time, which it is said the owners would grant only at a very large price, he relinquished the option.

As a side light, this story has a moral. Many a prospector has died in poverty because he failed to realize that the consummation of a reasonable agreement can mean a profit for both parties,

[5] Schrader, F. C., Notes on the Antelope District, Nevada: U. S. Geol. Bull. 530, Part 1, pp. 87-98, 1911 (1912).

while a dropped option helps no one, and certainly does not aid the mining industry.

Geology. Lincoln summarizes Schrader's geology:

> The Cactus Range is composed mainly of Tertiary eruptives, according to Schrader, which rest unconformably upon Paleozoic sedimentary rocks which have been intruded by Cretaceous granite and diorite porphyry. The country rock of the Antelope Springs District is Tertiary rhyolite. The ore occurs in quartz veins filling fissures and in the altered rhyolite adjoining these veins. A little adularia is present with the quartz in the veins, and the rhyolite has been altered by silicification, sericitization, kaolinization, and alunitization. The ore minerals are hornsilver, argentite, and native gold, much of which contains silver. Limonite, hematite, and manganese oxide are common.

Properties. The Antelope View group of two unpatented claims, located by Reilly and Jordan in 1906–1907, are now owned by Mrs. Margaret McAuliffe of Goldfield. The group lies 1 mile south of Antelope Springs.

High-grade gold discoveries on this property stimulated early activity in the district. The principal working is a 240-foot inclined shaft with 240 feet of laterals on the 60-foot level which opens to the surface. Water reportedly stands at 145 feet in the shaft. The ore occurs in narrow quartz veins in rhyolite. Although no production is of record it is said that about $80,000 has been produced from the claims.

The Gold Bug group of two unpatented claims are owned by Mrs. Margaret McAuliffe of Goldfield, and D. L. O'Meara of Madera, California. The claims lie about 3 miles southwest of Antelope Springs on the road to Goldfield. This area is locally known as Sulfide.

Narrow quartz veins are said to occur in rhyolite and have been explored by several shafts, pits, and trenches. Two of the shafts are 60 feet and 75 feet deep, and another of unknown depth is full of water. The claims have no known production.

It is of interest that these claims are approximately on the ridge of the mountain range and have encountered water. A well located near here is only a few hundred feet below the ridge.

The Jay group of unpatented claims lie a short distance due east of the Gold Bug group. They are owned by Edith F. Bush of San Bernardino, California, and others. Silver ore occurs in

narrow quartz veins striking northeasterly in rhyolite. The occurrence has been explored by several shafts, the deepest being 100 feet. All the workings total about 600 feet.

ARROWHEAD

The Arrowhead district could possibly be included with the Reveille district, adjoining on the south, as it represents only a rather small area at the north end of the Reveille Range. It is reached by an unimproved desert road from near Twin Springs. The areal geology is similar to that of the Reveille district except that Tertiary volcanics are more prevalent. Lincoln states:

> The country rocks of the Arrowhead Mine are andesite and rhyolite. The ore body is a replacement vein from 3 feet to 8 feet in width carrying pyrargyrite and argentite as the principal ore minerals. A minor amount of gold is present.

Mineral Resources of 1920–1922 show a small production of silver and lead ore during those years and Couch shows a recorded production of $4,755 from 225 tons mined in 1920 and 1939. During the latter year 195 tons grossed $2,684. There is no indication of activity in the district between these years nor after 1939.

Most interest in the area was apparently in the early twenties. The Arrowhead Mining Company had a 345-foot inclined shaft with work on four levels and the Arrowhead Extension Mining Company was working in a 150-foot shaft.[6] The district must have been ideal for promotional purposes as 10 companies were organized for work here during 1919–1922. No activity has been noted in the district for many years.

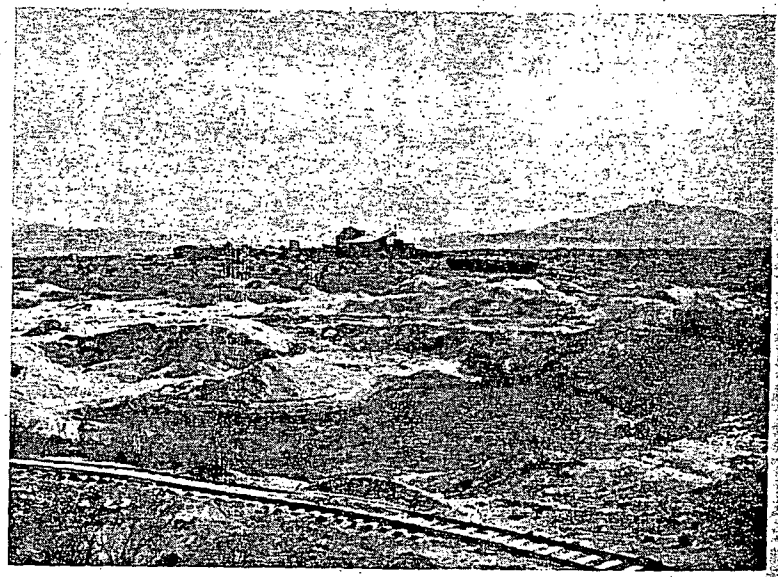
ASH MEADOWS

The Ash Meadows district is in the southern part of Nye County bordering on California. The district covers a large sink and meadow area in the lower part of the Amargosa Desert that drains into the Amargosa River in California. The altitude is about 2,200 feet and winter weather conditions are mild; summers are hot. Roads are generally poor for wet-weather travel and fair in dry weather; however, State Highway 29 passes within one-half mile of the principal mining area. The earliest known activity is mentioned by Mineral Resources (1917) which states, "Groups of claims containing clay like that at Zabriskie and Ryanbone, Cal., have been located in Ash Meadows, Nev., along

[6] Mines Handbook, Vol. XV, p. 1136, 1922.

the California-Nevada State line. It is stated in a prospectus issued from the same source from which the Zabriskie-Shoshone enterprises originated that a stratum of brown, spongy clay encountered in numerous holes, the deepest of which was bored 38 feet, invariably carried 4 to 8 percent potash (K_2O). The potash in this brownish clay is said to be over 90 percent soluble in water." The article goes on to say that the statements have not been verified and that since the average potash content of muddy sediments for the entire earth's surface has been computed to be 3.25 percent, the claims need verification by someone experienced in the practical aspects of such potash ventures.

The first mention of the use of the clay in its natural form was



(7) Bentonite pits and Los Angeles Chemical Company plant at Ash Meadows.

in Mineral Resources (1918) which states, "The most promising development of the year was the utilization of a deposit of earth in Ash Meadows, Nye County, Nev., near Death Valley, Calif., which is reported to be very large. This material is known in the trade as 'Death Valley clay,' probably because it was first reported as coming from Death Valley, and is said to be excellent for filtering mineral oils."

It appears that a fairly steady production has been made from the district since 1918, however, not all production has been recorded. Including the year 1949, recorded production from Ash

Meadows is 179,929 tons valued at $2,901,466, with the largest recorded annual production, in 1929, being 34,492 tons valued at $571,393.

Geology. The clays are a part of lake beds referred to by Ball[1] as late Pliocene and Pleistocene. The beds are essentially horizontal and those that have been mined are all on the periphery of Ash Meadows and slightly above the valley floor. The material is commonly known as bentonite and is largely composed of the mineral montmorillonite.

Properties. Although several deposits in various parts of the district have been mined, the property about 10 miles north of Death Valley Junction, operated for many years by the Coen Companies and now by the Los Angeles Chemical Company, has made essentially all the production. This property is on the west side of the meadows while others are north and east of the meadows. During the years of operation, mining has spread over an area about one-half mile square and exploration ahead of future mining covers an area many times this size. The desirable bentonite clay is found in somewhat circular and irregular bodies as much as 100 feet across. The thickness of the beds varies and they usually feather out at the edges. The thickest bed was mined from surface to 24 feet at which point the bentonite was still good but the depth considered too great as the water is relatively near the surface. Water level is held down to about 15 feet with a 3½-mile drainage ditch. All mining and exploration is done with a crawler track-mounted drag line. Much of the clay is quite wet, as mined, and is allowed to dry about two months prior to handling in the plant. The mining and hauling by gasoline-powered locomotive is handled by one man who can mine about 200 tons of clay per day with the drag line. Stripping has thus far been a minor item as enough clay bodies have been found near the surface.

The processing plant is relatively simple as it is only necessary to dry, crush, size, and sack the clay. The general flow-sheet is from a toothed set of rolls, to an oil-fired rotary kiln, to two sets of rolls in series with screens, to sacking, or to a Raymond mill for a finer product which is also sacked. About five products are produced at the present time, ranging in size from plus 40 mesh to minus 325 mesh. The plant has a capacity of 15 tons per 8 hours and produces about 200 tons per month. It is operated by three men including the superintendent. Power is supplied by a

[1] Ball, S. H., A Geologic Reconnaissance in Southwestern Nevada and Eastern California: U. S. Geol. Survey Bull. 308, p. 160, 1907.

50 h. p. Caterpillar gasoline engine and a 125 h. p. Caterpillar Diesel engine. A planned electric power line from the southeast to supply Shoshone, California, and Pahrump Valley, may also be extended to the Ash Meadows area at which time this plant will probably be rebuilt. Most of the clay is now used either as a filtering media or an absorbent. At one time much of the bentonite was used as a drilling mud, however, little or none of the Ash Meadows material is now being used for this purpose.

ATHENS

The Athens district borders Mineral County and is about 30 miles by road northeast of Mina at elevations ranging from 6,000 to 7,000 feet. The road from Mina, nearest highway and railroad point, is a good improved dirt road except for the last few miles. Water is scarce and must be hauled. Weather conditions usually allow year-around work. The earliest work in the district was done at Pactolis, which had a few years of boom activity after the discovery of high-grade gold ore in about 1903. The recorded district production as per Couch is $71,724. This has all come from the Warrior, which is the only producer in the district.

Tertiary lavas of rhyolite, dacite and some andesite, with later Siebert lake beds in some areas, make up the formations found in the district. Gold and silver, occurring in quartz veins and shear zones, are the principal economic metals.

Properties. The Warrior mine, the principal property in the district, situated about 4 miles north of the Simon lead mine, is owned by Harry McNamara of Tonopah. A veteran of the Civil War, of unknown name, grubstaked by Millett, a storekeeper of Manhattan, discovered the property in about 1912. The first appreciable work was done in 1915 when a small amalgamation mill was installed. It is doubtful that this project met with much success but apparently some ore was milled at the Omco mine, 4 miles west in Mineral County. Lincoln mentions a $20,000 production from the Warrior. The largest production from the property was made, after the advance in the price of gold, in 1934. Lessees worked the mine intermittently during 1934–1946, shipping to the Dayton Consolidated custom mill at Silver City. Production records show the ore to have averaged $22 per ton, on which the lessees paid a 15 percent royalty. The veins appear to be made up of quartz stringers in shear zones occuring in the rhyolite and dacite. The ore is said to average about 4 feet in width and the mine is said to have much $10 ore that could not be shipped. The workings consist of two inclined shafts, the

older being 200 feet in depth with about 1,300 feet of laterals on two levels and having a headframe of doubtful stability. The last work in this shaft was said to have been done in 1939. The other shaft, which has been used more recently and is smaller, has an estimated 200 feet of workings with timber and headframe in good condition. Improvements consist of several old camp buildings in rehabilitable condition.

Pactolis is an old boom camp that had a little activity on high-grade gold occurrences during 1903–1907. The patented lode claims here are owned by Sam J. Eva of San Francisco. The group lies in low rhyolite hills about 5 miles northeast of the Warrior mine and 7 miles southeast of Goldyke. No activity has been reported in the district for many years.

BELLEHELEN

The Bellehelen district is 50 miles east of Tonopah and about 5 miles air line south of the Tonopah-Ely highway. Mrs. Byrd F. W. Sawyer,[8] of Fallon, states that the town was named for two mules and was never more than a tent city, however, at one time had a population of 500. The date of discovery is not known but is assumed to have been shortly after the turn of the century. Apparently several companies were organized on the strength of ore found here and Weed[9] reports that the Pacific States Mining and Milling Company had a production of $117,000 during 1917–21. This company and the Tonopah Kawich Mining Company formed the Bellehelen Merger Mines in about 1922 and built a 50-ton cyanide mill the next year which, however, only operated a few months in 1923. The mill was rehabilitated and operated about 9 months in 1927, but no record of production for this period was noted. Couch shows the only recorded production from the district as $29,473 from 438 tons produced by Cornforth & Sweet in 1918, which probably came from a group now known as the Doreen. It is reported that ore valued at about $4,000 was shipped from the old Peterson Mine in the west end of the district in 1935.

Geology. The area is largely rhyolite overlying a granite exposed south of the areas of principal activity. Mineral values are in silver with small amounts of gold, the silver usually occurring as the chloride. Jay A. Carpenter[10] in describing one property

[8] Sawyer, B. F. W., Gold and Silver Rushes of Nevada, 1900-1910, University of Calif., Doctorate thesis, p. 103, 1931.
[9] Weed, W. H., Mines Handbook Vol. XVI, p. 1282, 1925.
[10] Carpenter, J. A., Private Report on Tonopah Kawich Mining Company, 1918, in Bureau files.

in the district states, "The rhyolite formation of the mountain was at one time subjected to an intense east and west vertical fissuring. These many parallel fissures can now be easily traced along the whole south side of the crest, show prominently on the face of the bluff, and have been exposed in surface cuts for over a mile farther to the west. Mineral bearing solutions ascended in many of these fissures depositing quartz with iron and silver minerals, and these quartz veins and stringers, while very small, are nearly as regular and as easily traceable as the fissuring itself.

"There is a rather prominent fracturing of the rhyolite at right angles to the fissuring, but there is no silicification or any evidence of post mineral movement along these fracture planes, and in addition the unbroken continuity of the outcrop of the quartz veins points to veins remarkably free from faulting."

Properties. The Bellehelen Merger Mine's ground is now owned by the Western Gold Corporation, title having been transferred in 1930. The property has several thousand feet of workings, however, it is understood that no appreciable work has been done here since the twenties. The mill was removed during World War II. Available data indicate that the ore was usually 12–18 inches wide and contained about 50 ounces of silver per ton. Some of the shoots mentioned by Carpenter measured about 100 feet by 200 feet.

The Peterson mine, also known as the Holiday group and owned by the Fallini brothers of Twin Springs, is just west of the Bellehelen Merger. They state that about $4,000 of high-grade gold ore was shipped in 1935, however, nothing has been done here in recent years. The ore reportedly occurs in short shoots and pipes. A 600-foot adit and other workings total about 1,000 feet.

The South Star mine, half a mile southeast of the Bellehelen Merger, is also owned by the Fallini brothers. The ore values are said to be largely in silver with some gold, the silver occurring as the chloride in veins 2 inches to 3 feet wide. Some $15 ore is reported to be in sight. The workings consist of a 75-foot shaft and about 200 feet of short adits and cuts.

The Cedar group, owned by C. A. Anderson of Tonopah, lies about one-half mile north of the Bellehelen ranch. The owner reports that he has mill ore exposed on several of his claims and that the ore contains gold and silver with some vanadium. He states that the greatest depth of the workings is 100 feet and that 150 feet of drifting has been done on the ore. The claims were located in 1927 and the next year reportedly made a small production.

The Doreen group, owned by W. B. Naismith and Lee Henderson of Tonopah, is said to have been first worked in about 1915. It is believed that the $29,473 recorded production shown by Couch came from this property. Apparently very little work has been done here in many years. It has one adit and no improvements.

BELMONT (Philadelphia, Silver Bend, Barcelona, Spanish Belt)

The Belmont mining district, also commonly referred to as the Philadelphia district and in the early days as the Silver Bend, lies on the east side of the Toquima Range at an altitude of about 7,000 feet. The town of Belmont is 46 miles by road northeast of Tonopah; of this distance 19 miles is paved, and the balance is well-maintained dirt road. The Barcelona or Spanish Belt area, situated almost on the crest of the Toquima Range at an altitude of about 9,000 feet and 8 miles air line northwest of Belmont, is usually included in the district. The area in the vicinity of Meadow Canyon is also here included.

Discovery of the district was made near the site of the town of Belmont in 1865.[11] High-grade, surface-enriched silver chloride ores mined here in the early days made the camp very prosperous. In 1867 the Nye County seat was moved from Ione to Belmont where it remained until is was moved to Tonopah shortly after the turn of the century. The old red-brick Nye County courthouse, still standing at Belmont, is one of the principal landmarks of the State.

Production figures indicate that Belmont was fairly active until about 1887. Couch shows the recorded production from the district as $3,793,103 from 58,906 tons. Part of the total production may not have been recorded with the State, as so often happened in the early days of Statehood; Lincoln reports a much higher figure.

A drop in the price of silver, the added cost of pumping from greater depths, and the usual drop in silver content of the primary ores all shared the responsibility of a dormant period from about 1887 to 1916.

In 1915 the Monitor-Belmont Company, after taking over the principal mines and bringing electric power from Manhattan, built a flotation mill to treat the old dumps. During the next year it is reported that the company was treating an average of 120 tons per day in its 10-stamp mill. The mill was shut down in 1917

[11] Emmons, S. F., Report of the Geological Exploration of the Fortieth Parallel, Vol. III, pp. 393-405, 1870.

and this was the last production made from the old Belmont mines. The tonnage and value recovered by this company was appreciable but no report was made to the State. The masonry walls of the mill still stand as a landmark.

The Nevada Wonder Mining Company took an option on the property in 1918. Under the superintendency of Jay A. Carpenter, a period of eight months was spent unwatering and sampling the old workings before the option was relinquished without the mining of any ore.

The Barcelona or Spanish Belt part of the district was responsible for about $200,000 of the total district production and $33,500 of this was made during the period 1920–1922.

Geology. The areal geology may be described as Ordovician shale and limestone intruded by a large mass of granite that extends to the Round Mountain district. The Belmont ore occurrences are briefly but well described,[12] "The geology of the portion of the district owned by the Monitor-Belmont Mining Co. may be briefly described as quartz veins and lenses occurring in slates and limestones at or near their contact with intrusive siliceous granites. The alteration of the intruded rocks to mica schists and jasperoid is noticeable. The metallic minerals occur in the quartz as bunches; no banding has been noticed."

Stetefeldtite,[13] a rather rare argentiferous antomonial sulfide reported to contain silver, antimony, copper, lead, iron, and sulfur is said to be the source of the silver in the Belmont ores. If this combination is a mineral rather than a mixture, and it may be the latter, it would probably be partzite due to the lead content. Dana's System of Mineralogy shows stetefeldtite to contain no lead. Regardless of the primary mineral, the oxidized ores containing the silver chloride were probably of the greatest importance.

Sheared quartz veins containing wolframite are found in several places in the granite south of Belmont. Only minor work has been done on these occurrences and no known tungsten production has been made.

Turquoise is found in the extreme southern part of the district at a camp called Monarch. Shaly limestone here has been highly altered and silicified to a jasper.

In the Barcelona or Spanish Belt area, which is in the northwestern part of the district, molybdenite has been found in and

[12] Hughes, Wilson W., The Belmont Camp, Nevada: Engineering and Mining Journal, Vol. 103, No. 23, p. 1008, June 9, 1917.

[13] Emmons, S. F., Report of the Geological Exploration of the Fortieth Parallel, Vol. III, pp. 393-405, 1870.

near the workings of the old Barcelona silver mine. The molybdenite reportedly occurs in the metamorphics near the granitic intrusives.

In the Meadow Canyon area, in the extreme northern part of the district, a small mercury mine and a gold and silver deposit are found in the metamorphics.

Properties. Director Jay A. Carpenter, who in 1918–1919 was in charge of pumping out and examing the workings of the Highbridge and Belmont shafts, has furnished the following information.

The Nelson Brothers had conducted a very profitable assay office in Goldfield and, enthused by their uncle's stories of the rich mines of the flooded Belmont district, organized the Monitor Belmont Company. They planned to mill the large dumps and from the profits to pump out the mines.[14] Both the low values in the dump ores and the low extraction by flotation of the oxized minerals resulted in no profit for the unwatering of the mines.

The Nevada Wonder Mining Company, impressed by past production records and by the strong quartz veins and the surface cuts, then took over the property under option. Hoisting and hailing equipment was installed at the Highbridge shaft and at the Belmont shaft about 1,600 feet southerly, with the water standing at about 50 feet from the surface. There were no maps of the underground workings, but hearsay accounts were to the effect that the Highbridge and Belmont were connected on the 300-foot level and that the 500-foot level of the Belmont had furnished a large tonnage of ore.

Fortunately, Mr. Carpenter was told of the old Belmont newspapers on file at the county courthouse and, from the progress reports of the mines contained therein, he drew up a crude but valuable map. This map disclosed the most important facts that the Belmont had drifted toward the Highbridge on the 500-foot level, not the 300-foot level, and at 60 feet from the line had raised all the way to the surface ores, and that the drift from the 300-foot level of the Highbridge had connected with this Belmont raise just below the old reportedly large body of refractory sulphide ore. The Highbridge shaft was sunk to 360 feet and the Belmont to below the 600-foot level. The reported weekly tonnage of ore was usually low in amount but high in value.

The papers contained much of human interest from "necktie party" hangings to the presumed suicide of the Indian maid Maggie by jumping down into the flooded Highbridge shaft.

[14] The Belmont Camp, Nevada, E.M.J. June 9, 1917.

By the use of bailers on both shafts the removal of 300 gallons per minute lowered the water steadily. Many hundreds of feet of old drifts were cleared out or crawled through, and old stopes explored. Both cut and grab samples were generally low in value. The stopes were fully gobbed with white vein quartz of low value but the old cowhides indicated that the high-grade ore next to the hanging wall had been mined separately and carried to the ore passes. This checked with the old newspaper reports of but a few cars a day of high-value ore. The 300-foot Highbridge and the 400-foot Belmont levels did not give sufficient encouragement for further unwatering.

The most exciting day was that of breaking down the heavily-hinged, chained, and padlocked gate on the 300-foot level of the Highbridge, and sampling the rich-looking sulphide ore in the Belmont raise, heavy with pyrite and sphalerite. The most depressing day followed when the assays showed but traces of silver. An amusing day was when a shaftman in the Highbridge brought up a skull from a wall plate that was immediately identified by Indian friends as Maggie's skull!

There was apparently no connection between the Belmont and the El Dorado shafts to the south as the water was lowered but little in the El Dorado. This was a disappointment as the El Dorado inclined shaft indicated the most consistent stoping above water level, and the newspaper reports indicated good ore on the 400-foot level of the vertical shaft at the time the surface plant was destroyed by fire.

At about the same time as the Nevada Wonder operation, Donald C. Cameron erected a cyanide leaching plant for the treatment of tailings. However, he found to treat only 3,000 tons of old-time tailing. Since the mines had a sworn production of over 50,000 tons, it is possible that much of the richer ore mined during the early days was hauled to Austin for treatment.

Mr. Cameron also successfully treated 19,000 tons of the Monitor Belmont flotation tailings, having an average content of 4.1 ounces of silver per ton. A 70 percent recovery was made indicating a high silver chloride content that had not been recovered by flotation.

The ruins of the Combination mill, with its high brick stack standing along side the county road to Monitor Valley, is a most impressive sight. Couch shows a recorded production of $38,012 from 421 tons made in 1873 by the Combination mine and $795,891 from 13,365 tons recorded from the Highbridge mine during 1866–1887. It is believed that the Combination ore came from the

Highbridge workings. J. D. Hague,[15] in describing the Belmont mines, reports that the Combination mill produced $160,000 of bullion in the first half of 1868 but stood idle most of the later part of the year. He adds that the mill was built at a cost of $225,000.

The Highbridge patented claim, from which it seems the Combination mill production was made, lies at the north end of the Belmont mines, southwest of the mill ruins. This and two other adjoining patented claims are owned by Ben and John Zunino of Elko. The Highbridge shaft is at the south end of the claim.

The Transylvania claims, two patents adjoined by two later patented outlying claims, lie south of the Highbridge and are owned by Charles D. Keough of Tonopah. The Belmont shaft is on this ground and the masonry ruins of the Monitor-Belmont mill are adjacent and northeast of the mine workings. Couch shows a recorded production of $348,245 from 7,831 tons during 1867–1887 by the Belmont mine, and $733,852 from 9,366 tons during 1866–1875 by the Transylvania mine. This production was undoubtedly taken from the same workings now known as the Belmont shaft. Mr. Carpenter's information disclosed that much ore taken out of the Belmont shaft came from the oxidized ore near the upper Highbridge workings.

The Eldorado South, which Mr. Carpenter mentions as having favorable reports in addition to showing continuous stopes, is in the southern part of the main Belmont area. The Eldorado South and two patented claims to the northwest, the Independence and Monitor, are owned by Arthur N. Carter of Lund. The combined recorded production from these claims, as shown by Couch, is slightly over one million dollars from about 10,000 tons. Two-thirds of this came from the Monitor during 1871–1875.

The Arizona patented claim, also known as the Canfield mine, adjoins the Monitor on the north and has a production recorded as $493,779 from 6,036 tons during 1868–1874. This claim now belongs to Nye County.

It is to be noted that recorded production of ore from underground at Belmont ceased 60 years ago, and the production from the short revival of the camp 30 years later was from mine dumps and tailings.

The Barcelona, or Spanish Belt silver mine, believed owned by Tom Nicely of Tonopah, lies about 8 miles northwest of the town of Belmont. The mine is said[16] to have been discovered in about

[15] King, Clarence, 40th Parallel Survey, Vol. III, pp. 401-3, 1870.
[16] Hunt, S. Frank, Mining Geology Outlined, pp. 1-5, 1936.

1870 by one of several Mexican Prospecting parties outfitted by Emanuel San Pedro. This man did much work in the early days of Grantsville and Ellsworth in the northwestern part of the county and may have been responsible for the early work in the San Antone district.

Couch shows a total recorded Barcelona production of $198,952 from 7,854 tons, of which amount $165,456 from 4,843 tons was produced during 1875–1889. The balance was mined by the Consolidated Spanish Belt Silver Mining Company during 1920–1922. This company installed a 50-ton flotation mill in 1921 which operated about a year.

The presence of molybdenite in the area has added interest to the mine in recent years and some work was done on these exposures in 1942–1943 by J. C. Perkins of Tonopah. Trenching of a disseminated occurrence in hornfels near an alaskite intrusive found the material to contain 0.39 to 3.0 percent molybdenum.

The principal working is a long adit reported to be 2,000 feet or more in length. Molybdenite is also said to occur in this adit.

The Van Ness mercury mine, believed owned by John Connolly of Tonopah, is well described by Bailey and Phoenix. The property lies at an elevation of 8,600 feet, about 6 miles northwest of the town of Belmont. Since its discovery by Jack Humphrey in 1928 it has produced 728 flasks of mercury. Most of the production was made by Raymond Van Ness in a 30-ton Cottrell furnace in 1930–1931. Since 1931, during the period of high mercury prices, lessees produced 25 flasks annually from retorts. The rotary furnace is believed to be on the property. The principal workings are two glory holes tapped with a haulage adit, and a 135-foot inclined shaft with stopes. A 900-foot adit driven to explore the ore at depth has produced little.

The War Eagle group, owned by W. A. Flower of Tonopah, lies 1½ miles above Flower's camp in Antone Canyon which is 12 miles by road north of the town of Belmont. Gold and silver values associated with lead and copper minerals are reported found here in metamorphosed shale and limestone. The workings consist of a 500-foot crosscut adit, a 75-foot adit and several shallow shafts. The longer adit is said to require another 200 feet to reach the vein.

The Fiorite group of mercury claims, owned by W. A. Flower and W. F. Logan, is situated near Flower's camp in Antone Canyon. Bailey and Phoenix describe the property and report that about 50 flasks of mercury have been produced since its discovery by Mrs. Flower in 1908. Small quantities of good-grade ore have been sorted from the workings in a 30-foot rib of silicified sediments. The property is equipped with a two-pipe, oil-fired retort.

Several groups of placer claims have been located in both Meadow Canyon and its branch Antone Canyon. Nine holes sunk 1 to 20 feet to bedrock are said to have panned about $0.30 in gold per cubic yard on bedrock.

The Titanium placer group, located by W. A. Flowers, lies near the junction of Antone Canyon and Meadow Canyon. A concentrate of the material from here is said to have contained 12.3 percent titanium oxide.

The Senator mercury mine, described by Bailey and Phoenix, is owned by George J. Barry of Los Angeles and lies at the head of the north fork of Mariposa Canyon on the west slope of the Toquima Range. It is reached by 3 miles of pack trail from the end of the Shoshone Canyon road east of Round Mountain. About 100 flasks of mercury have been produced from here since the discovery of the property in about 1925. The mercury is said to occur as cinnabar and metacinnabar in veins in granite. The workings consist of several adits, the longest of which is 90 feet.

The Monarch camp, of unknown ownership, lies about 15 miles by road south of Belmont. The claims appear to have been located for copper and turquoise, as some poor-grade gem material is found in a deep trench. In the area, apparently once located for copper, a ferruginous chert and jasper shows some faint copper stains. Two buildings here in liveable condition appear to have been used in the last 10 years.

Old wolframite workings are found about 5 miles southwest of the town of Belmont. The tungsten mineral is found in quartz veins that show considerable shearing. The workings are minor, consisting of shallow shafts and cuts.

The "pebble quarry," identified by several dumps on the north side of the Belmont-Manhattan road, lies about midway between the two towns. H. G. Ferguson[17] describes this old property.

> A deposit of silicified tuff occurs on the east side of the Toquima Range, close to the Belmont Road, about 8 miles from Manhattan. This rock is quarried and after rough grinding in a tube mill shipped to Manhattan, Tonopah, and Goldfield for use in tube mills. The quarry is known

[17] Ferguson, H. G., Geology and Ore Deposits of the Manhattan District, Nevada: U. S. Geol. Survey Bull. 723, p. 79, 1924.

as the Maris "pebble mine." The country rock consists of some of the finer-grained members of the Bald Mountain lake beds. They are here tilted at low angles to the north and are cut by irregular dikes of Maris rhyolite. The silicification of the shaly lake beds appears to be largely confined to certain favorable beds, which have been more or less brecciated. In thin sections of the best grade of material the minutely brecciated structure can be seen, the little fragments lying at all angles and almost completely replaced by minutely crystalline quartz in a matrix of finely banded quartz and chalcedony. This brecciation aids in giving the requisite toughness to the material, for unbrecciated tuff, even though silicified, tends to split along the bedding planes.

On a cost basis, this material has been found to compete satisfactorily with the Danish pebbles ordinarily used, but owing to the isolated position of the deposit the high cost of transportation prevents its widespread use in other districts.

BRUNER (Phonolite)

The Bruner district is relatively small and is situated at the north end of the Paradise Range bordering the Churchill County line. It adjoins the Mammoth district on the south. The earliest reported work in the area was at the Paymaster in 1906. The Penelas mine has been the only important producer, with a total recorded production of $898,629 having been recovered from 69,001 tons during the years 1936–1940.

Geology. Tertiary rhyolite and andesite lavas cover the area. The 1,000-foot, 73° inclined Penelas shaft on the east flank of the range is reported not to have cut through the lava covering. Meta-volcanics exposed a few miles south in the Mammouth district probably underlie the Tertiaries. Free gold associated with silver and occurring in quartz veins in the younger volcanics is the principal ore mineral.

Properties. The Penelas mine, so named after the locator who made the discovery before World War I, is situated in the southeast part of the district, on the east flank of the Paradise Range, and about 14 miles northwest of Ione. The Penelas Mining Company, of which L. D. Gordon of Reno is president-manager, operated the mine from 1931 to 1942. A 50-ton cyanide mill was built in 1935, and the installation had the distinction of being one of the most efficient small operations in the State. To facilitate

communication from its remote location, prearranged short wave radio contact was made with Fallon, 80 miles distant by road. When the ore was exhausted in 1940, the operation was shut down and all surface plant subsequently sold. Only the shaft, stopes caved to the surface, and the tailing pile remain as evidence of past activity.

The Penelas ore occurred in two veins, both in andesite and rhyolite, having an average width of about 5 feet. Mining was done on nine levels spaced 100 feet apart with about 4,000 feet of laterals. The 6th, 7th and 8th levels are said to have been the most productive, the main ore shoot having been about 150 feet long. As stated by L. D. Gordon, no values were found below the 900-foot level.

The Ole Peterson mine, operated by Peterson in 1936 as the Golden Eagle, is the southern and more important retained part of several adjoining properties purchased in 1915 by the Kansas City-Nevada Consolidated Mines Company. It is situated along the crest of the north end of the Paradise Range about 15 miles northwest of Ione. The Penelas adjoins this property on the southeast. The present owner is Mrs. Esther Peterson of Superior, Wisconsin. The mine was last leased to John Chisholm and George Erwin who made periodic shipments of gold ore in 1938.

At the Paymaster claim on the north end of the group the ore occurs in a poorly defined zone along a rhyolite-andesite contact. An excellent one and one-half compartment 375-foot shaft, with levels each 125 feet and about 2,000 feet of laterals, was sunk prior to 1920. Except for the collar set, the timbers show no signs of decay and the ladders are in good condition. It is reported that the principal values were found above the 125-foot level and that careful selective mining was necessary. A 50-ton cyanide mill, built in 1919 and destroyed by fire a few years later, was apparently unjustified as no recorded production is shown for the company. Broken Hills, 12 miles west, was probably the principal source of ore for the mill. Little or no work has been done on the Paymaster since about 1923.

The July Lode, at the south end, is the only part of the property having an appreciable production. It is from here that Ole Peterson and leasers are said to have produced about $70,000 in the years 1936 to 1944. The ore occurence here is different from the Paymaster in that quartz is more abundant and the ratio of gold to silver is much greater. The values are found in a brecciated rhyolite recemented with quartz and occurring in a chimney-like ore shoot approximately 14 feet by 8 feet in cross-section which

has been stoped to the surface. The mine is opened by two connected adits totaling about 400 feet in addition to several minor workings. Improvements consist of a 50-ton ore bin and several buildings in good condition.

The Derelict mine, a gold property consisting of two claims, is west of and adjoins the Ole Peterson. It was originally part of the Penelas estate, however, in recent years has been relocated by Mory Stromer of Broken Hills. Although the mine has no recorded production, it is reported that shipments were made in 1939. The workings include a steeply inclined 300-foot shaft. Gold ore is said to occur here in a recemented brecciated rhyolite.

BULLFROG (Beatty, Pioneer, Rhyolite)

The Bullfrog mining district includes the vicinity of Beatty west of the Las Vegas highway and the region near the old towns of Rhyolite and Pioneer. It adjoins the Fluorine district on the west. Topographically the Bullfrog district covers all of the Bullfrog Hills and also includes properties in the adjoining part of the Grapevine Mountains. Beatty is on the Tonopah-Las Vegas highway, 93 miles from Tonopah and 114 miles from Las Vegas.

As stated by Mrs. Byrd F. W. Sawyer, of Fallon, in her "Gold and Silver Rushes of Nevada 1900–1910,"[18] the Bullfrog district was discovered on August 8, 1904 by Shorty Harris and Ed Cross. The discovery was made at what is now usually referred to as the Original Bullfrog mine about 4 miles west of the town of Rhyolite. The name is said to have been suggested by the green color of the gold ore associated with copper in a bold quartz outcrop. Such choice of name on an August day in this arid section is subtle to say the least.

Ransome, Emmons, and Garrey in U. S. Geological Survey Bulletin 407 on this district mention that long before the discoveries of Tonopah and Goldfield, settlers had established ranches at the springs of Oasis Valley just north of the present site of Beatty. The roving prospectors of that day occasionally prospected the hills in this area but the rich discoveries to the north gave impetus to the prospecting which resulted in the Bullfrog discovery. In a very short time the area between the Bullfrog group and the Amargosa River was covered with claims.

The first railroad to come into the area was the Las Vegas and Tonopah which reached Beatty on October 22, 1906. Two months later it was extended to Rhyolite which by this time was the principal town in the district. Competition for the Bullfrog district

[18]University of Calif. doctorate thesis, 1931.

freight was keen as the area finally had three railroads. The Tonopah and Tidewater came up across the desert from California and the Bullfrog and Goldfield came down from Goldfield. This gave the new camp transportation facilities comparable or superior to older and better established districts. These facilities were absolutely necessary as the quantity of high grade that could stand a high wagon-freight cost was small in the Bullfrog district. Figures taken from Ransome show about 113 tons shipped by the end of 1905 with small unrecorded shipments in 1906. However, in 1907 the production was about 9,000 tons valued at $264,964.

Transmitted electric power is another important facility obtained by the mines in the Bullfrog district. The Nevada-California Electric Power Company, which had previously brought its lines into Tonopah and Goldfield, extended its distribution system to include the Bullfrog area. This was important to the Montgomery-Shoshone and the Tramps mines as each installed mills. The mines and mills of the Pioneer area in the northern part of the district also benefitted from this source of power.

Couch shows the total recorded production of the Bullfrog district to the end of 1948 to be $1,885,778; however, the four grand years were 1907–1910 during which $1,687,792 was recovered from 158,594 tons, or an average of $10.65 per ton. Of this amount the Montgomery-Shoshone in this period produced $1,344,105 from 128,980 tons or $10.42 per ton. These figures show that Bullfrog ore was generally low grade.

Ransome states:[19]

> From this summary it appears that the Bullfrog district contains only one mine (Montgomery-Shoshone) of moderate size and of steady productiveness. The others are small and up to the middle of 1908 no one of them could be said to have emerged from the prospecting and experimental stage. Whatever the expectations excited from time to time by the finding of superficial bunches of rich ore, there can be no doubt that the veins as a whole are to be classed as low grade when the conditions under which they must be exploited are taken into consideration. They are in no way comparable with the remarkable bonanzas that have brought fame to Goldfield and can not be successfully worked by the same methods.

[19]U. S. Geol. Survey Bull. 407, p. 92.

The Pioneer district is considered as part of the Bullfrog and the production is included with the figures given. Recorded production is only shown for 1909–1910 and is $44,491 from 2,122 tons or a value of $21 per ton. Sawyer reports the discovery of the Pioneer mine to have been made here in 1907 by an employee of W. J. Tobin, but the excitement over the strike lagged and the actual boom did not come about until December 1908. The Mayflower mine, adjacent to the Pioneer, had been working since 1906. The Pioneer area has had intermittent activity since the early days but only a small production has been made since 1910.

Present conditions in the Bullfrog district are considerably changed from what they were in the boom days of the camp. Beatty is now the principal town and, although some intermittent mining is done in this district and the Crowell Fluorspar mine is active in the adjoining Fluorine district, the main source of income is probably the tourist business. Roads to the mines in the area are good and general climatic conditions allow work and access to the properties the year around. The nearest rail point is now Las Vegas, 115 miles distant. The Tonopah and Tidewater, the last railroad in the area, discontinued service in 1939. The Nevada-California Power Company's lines have long since been removed, the company having ceased supplying power in December 1916. The only present power source is a diesel-electric plant in Beatty supplying power for domestic use in that community.

Geology. As Ransome, Emmons and Garrey made a complete study of the Bullfrog geology, it will be best to quote directly from their writings.[20]

> The prevailing rocks of the area studied—the ones that give character to the topography, and contain the ore deposits—are rhyolitic flows of Tertiary age. Much older rocks, however, are exposed in the southwestern and southeastern parts of the district.

These are schists, quartzites, marbles, and injected gneisses, all highly metamorphosed, overlain in some places by less metamorphosed limestone of probable Silurian age. They further state:

> The Tertiary rocks, which have an aggregate thickness of at least 6,000 feet cover most of the area and contain all the known ore bodies of importance. The greater part of the series is rhyolite, and sixteen successive formations of this rock have been recognized and mapped by Messrs. Emmons and Garrey. These formations are not necessarily individual flows. Some of them are really parts of a single thick flow, and others are certainly composed of several flows. Intercalated between the rhyolites are five flows of plagioclase basalt, one flow of quartz latite, some stratified tuffs, and finally capping the series, a flow of quartz-bearing basalt. The effusive rocks are cut by intrusions of rhyolitic porphyry, plagioclase basalt, and leucite basanite. Most of the basalt dikes occupy fault fissures.
>
> The Tertiary lavas and tuffs are generally conformable to one another, but at a few places slight erosional unconformity has been detected.
>
> The entire series of volcanic rocks is divided by faults into a large number of blocks in each of which the flows are in general tilted to the east at angles up to 40°. The fault planes strike from northwest to northeast and dip generally to the west. The displacement as a general rule, is normal; that is, the hanging wall in each case has slipped down relative to the foot wall. In consequence of this structure anyone traveling across the district from west to east will see the edges of the same flows repeated again and again in the successive western fronts of the ridges.

In regard to the veins they say:

> Most of the lodes are not simple veins, but are fissure zones (of nearly vertical dip) containing numerous veinlets or stringers of vein material and in most cases showing no definite walls. The principal stringers are parallel with the sides of the lode as a whole, but they are linked by numerous irregular cross veinlets, and similar small stringers extend for varying distances into the country rock. The lodes range in width from a few inches to 10 or even 100 feet.
>
> Typical vein quartz, such as is characteristic of the gold veins of the Appalachians or Sierra Nevada or such as is found in the pre-Tertiary schists of the Bullfrog district, does not occur in the mines near Rhyolite, with the exception of the Original Bullfrog. The quarts is prevailingly fine grained, often of a porcelain-like texture, and is usually intercrystallized with calcite.

[20] Op. cit., U. S. Geog. Survey Bull. 407, pp. 14-18.

All the ore thus far mined (1908) or opened is more or less oxidized and as a rule, contains no sulphides. In the Original Bullfrog mine there is a little chalcocite, or copper glance, and in some undeveloped veins in the schists south of Beatty there are specks of galena, but the only sulphide thus far found in the other deposits is pyrite. Native gold, alloyed with various portions of silver, is the only valuable constituent of most of the ores, although cerargyrite, or horn silver, is fairly abundant in the rich ore of the Montgomery-Shoshone mine. The gold is finely divided and is almost invariably found in the quartz, not in the calcite. Its characteristic association with little limonite specks, representing oxidized pyrite, has already been referred to.

Properties. The Montgomery-Shoshone was discovered in 1905 and, as per Ransome, Emmons, and Garrey, by the end of that year had been developed to a depth of 150 feet with a large body of rich silver-gold ore blocked out as a result. This property lies on the northwest slope of Montgomery Mountain about 1¼ miles northeast of Rhyolite at 4,000 feet elevation. When visited in 1908, by the above-mentioned geologists, the shaft was 600 feet deep and about 9,000 feet of laterals had been driven. According to news items in early issues of *Engineering and Mining Journal*, grading for the mill began in January 1907 and the mill started grinding in October of the same year. During that month, 3,000 tons of $25 ore were crushed. The mill was built to treat 300 tons per day but for various reasons, including difficult percolation, only about 200 tons per day were treated. The mill was equipped with amalgamation, concentration, and cyanidation; however, the amalgamation was abandoned very early in the operation. After the milling became well organized and the concentrates were cyanided, only bullion was shipped from the property. Steady production of 5,000 to 6,000 tons per month was made until the latter part of 1910 when it dropped off considerably. Finally the operation was shut down in the early part of 1911. The 1910 annual report to the stockholders reported 61,037 tons of $4.84 ore milled, $245,907 net bullion proceeds, 83.57 per cent recovery, $4.01 per ton mining and milling cost, not including interest and certain overhead charges, and a $55,360 loss for the year. Couch shows the Montgomery-Shoshone mine production as $1,388,398 from 141,376 tons, or an average of $9.82 per ton.

The principal ore body at the Montgomery-Shoshone was the

brecciated area between two north striking parallel veins at their north termination on the Montgomery-Shoshone fault which bears northeast. As explained by Ransome, the fault is a contact between rhyolite on the southeast and a down faulted segment of extrusive basalt on the northwest. The character of the veins as summarized by Ransome, "The veins worked in the Montgomery-Shoshone mine are filled fissures in rhyolite. As a rule, the fissuring is rather irregular with a tendency toward sheeting and brecciation. Consequently, most of the veins contain many fragments of rhyolite embedded in the materials deposited from solution." The ratio of silver to gold in the higher-grade, near-surface ores of this property was about 25 ounces of silver to one of gold; being much more silver than is characteristic of Bullfrog ores.

The workings are very extensive and go to the 700-level of the main shaft which is actually 600 feet deep as levels were designated relative to an old shaft on higher ground. It appears from old news accounts that water was encountered at a depth of 550 feet and that sinking was abandoned near 600 feet (700-level) due to an excessive flow. Most of the ore probably came from above the 300-foot level and the best is said to have been mined in the glory hole area. Some of this ore was reported to assay $700 per ton. It was from here that the higher-grade shipping ore was obtained before the mill was operating.

Although the headframe and shaft are in apparent good condition, and an old hoist is on the property, the mill and other improvements have long since been removed. Little is known regarding the condition of the workings. Some work was done at the property in 1938; however, no production has been recorded since 1911. The Montgomery-Shoshone is reportedly owned or controlled by Leo Meyberg of Los Angeles.

The Shoshone-Polaris mine, commonly known as the Polaris, is southwest of the Montgomery-Shoshone and the underground workings of the two mines are connected. As the Polaris shaft is now caved, access to the mine is through the Montgomery-Shoshone shaft. These two properties were operated together by the Montgomery-Shoshone Consolidated Mining Company, therefore the two mines are usually considered as one. Couch shows a recorded production of $101,081 from 9,522 tons during 1907–1910; of this amount $60,000 was produced in 1908. The average return on the ore was $10.62 per ton. The Polaris shaft as shown by Ransome in 1908 was 300 feet deep with levels at each 100

feet. The ore occurred similarily to the Montgomery-Shoshone in a north bearing vein near the fault and also along the fault. Some work was done at the Polaris in 1940; however, no production has been recorded since 1910. It is reported that a recent sampling disclosed 40,000 tons of ore averaging $11.10 per ton over a width of 5–6 feet. The Polaris mine is owned by the Leo Bocaccino estate of Beatty.

The Senator Stewart mine is on the east side of Ladd Mountain east of the town of Rhyolite. Homer Weeks of Beatty is working the property under lease and is also subleasing. At the time the mine was visited early in 1950, four men were working. Some shipments had been made to the Dayton Consolidated mill at Silver City; however, as the cost of treatment plus hauling is about $25 per ton, profitable mining is difficult. The property has been intermittently worked by lessees for many years. Minerals Yearbook for 1939 states that 181 tons yielding $39 per ton in gold was produced from the mine in that year. The Senator Stewart vein bears N. 20° E. and dips about 55° W. It is persistent and can be traced for at least 400 feet. The work is being done from two shafts, each about 100 feet deep. Improvements consist of two small headframes with hoists and one ore bin, all neatly arranged for efficient work.

The National Bank mine owned by Miss Bess Westmoreland of Cleveland, Georgia, is situated on the northwest slope of Ladd Mountain overlooking the old town of Rhyolite. Ransome states that a little ore had been shipped prior to 1906 but the property had not proved profitable. At that time, it was opened by a 200-foot vertical shaft with two short levels. The ore is said to consist of a silicified rhyolite with minute quartz veinlets, the gold being found in the rhyolite associated with limonite rather than in the quartz. Various news items in old issues of Engineering and Mining Journal show intermittent small production of ore varying from $65 to $463 per ton in the years 1907 and 1909. Couch shows no recorded production for the property.

The Tramps Consolidated mine, owned by Charles A. Liddell of Los Angeles, lies on the east slope of Bonanza Mountain overlooking Rhyolite from the west. The property includes the Gibralter mine on the southeast slope of Bonanza Mountain and the Denver Mine to the northwest; it is believed that the long Tramps adit cuts the Denver vein. Ransome states that the Denver mine was located in September 1904 and that intermittent shipments of sorted ore were made up to the time of his visit in 1908. The property has been worked principally by lessees and is one of the

mines in the Bullfrog district on which leasing has been active recently. Couch shows a recorded production of $22,407 from 541 tons during 1907–1910. During 1915–1916 the Sunset Mining Company operated a mill here; their production is recorded as $40,792 from 10,888 tons. It can be well assumed that appreciable unrecorded production has been made by lessees. The individual mines making up the Tramps Consolidated each have several parallel veins, most of which have a northerly trend and occur in rhyolite. One of the veins is associated with a basaltic dike. Development has been mainly by adits although several shafts have also been sunk. It is estimated that the group has over a mile of workings.

The Original Bullfrog, more recently known as the Burm Ball mine by the owners, J. Burmeister and W. S. Ballinger of Auburn, California, lies about 4 miles west of Rhyolite. The company did considerable work in the early thirties after taking over the property. They were reported to have retimbered the shaft to 220 feet and driven 2,400 feet of laterals on the 100 and 220 levels. They also built a 25-ton amalgamation, concentration, and cyanidation mill in Beatty in which 480 tons of ore from various faces were treated. It is reported that $15 per ton was recovered with a $6.90 tail. The mine has been operated intermittently by the company since this time with lessees doing some work during the last war and in recent years. Quoting directly from Ransome's description[21] of the Bullfrog lode:

> The deposit represents a mass of rhyolite that has been greatly fissured and shattered. The fissures have been filled with quartz and with minor amounts of calcite and ore minerals; and to a considerable extent the shattered rhyolite has been completely silicified.

The lode is nearly solid quartz, about 60 feet wide and dips 18–20° N. The fissuring here was probably caused by the flatly dipping Bullfrog fault which faulted the rhyolites against the Paleozoic series.

Ransome describes the characteristic Bullfrog ore, samples of which have by now entered mineral collections in the far corners of the earth. "The shipping ore consists of quartz that originally contained chalcocite, but the latter mineral has been nearly all changed to green, blue, and brown chrysocolla with a little malachite. Native gold occurs in visible particles embedded both in quartz and chrysocolla."

[21] Op. cit., U. S. Geog. Survey Bull. 407, p. 122.

Development is by several thousand feet of workings. The main shaft is 550 feet deep and the last work is said to have been done on the 115-foot level. Equipment on the property is in good condition and in readiness for immediate operation. Water is hauled from Beatty.

The Happy Hooligan mine, now known as the Patootse and owned by Charles E. and F. C. Phinney of Beatty, lies about 16 miles west of Beatty at the eastern base of the Grapevine mountains. Only minor production has been made from the property. Ball states that gold ore is found on the contact of an exposed section of limestone with the overlying basalt. The basalt is in turn overlain by a rhyolite. The exposed limestone here is unusual as the area has a general volcanic cover. He states that much alteration has occurred on the limestone-basalt contact and that free gold can be panned from the alteration products. The contact is traceable for several hundred feet and it is reported that gold values are found in all openings along the contact. About 1,000 feet of work, including a 300-foot shaft and two adits of 200-and 300-foot length, has been done on the property. The owners report that assays taken in the early days ran from $4 to $44 in gold and silver. The ore usually occurs in flat bodies 4 inches to 4 feet wide.

The July 4th and Happy Camp claims of the same ownership as above, and about 6 miles northwest, are situated at a spring about 2 miles northwest of Wahguyhe Peak. The group was located in 1930 and 50 tons of $17 gold and silver ore is reported to have been milled at Pioneer. The ore is free milling and occurs in shear zones and veins up to a 33-foot width in rhyolite. Samples across wide widths are reported to assay $4 to $12 per ton. About 900 feet of work has been done here in two adits.

The Niterville group, owned by Dr. W. R. Colbert of Elsinore, California, joins the July 4th group. The owner reports a wide width of $15 ore in rhyolite. Workings consist of a 200-foot adit, a 100-foot shaft, and several open cuts. The property has no known production.

The Homestake mine situated 6 miles northwest of Rhyolite is owned by Charles A. Liddell of Los Angeles. A 500-foot 63° inclined shaft was sunk here in the early years of the district and a well-built, 25-stamp mill erected in 1908. A news item of January 1909 mentions treating 75 tons of $7 ore per day. The mill operated less than a year when it was shut down for lack of ore. Couch shows a recorded production in 1908–1909 of $54,261 from 9,803 tons. It is reported that in 1940 considerable $35 ore found

in the footwall of the vein was shipped to the State Line mill in Esmeralda County. Some $20 ore is said to be left in the mine; however, there is now no profitable way to handle ore of this grade in the district. The Homestake vein occurs in rhyolite and strikes northerly. It is said that the more quartzose ore of the vein, which was mined in the early days, is not the best. The better-grade footwall ore, shipped in 1940, is a highly altered rhyolite containing much calcite but little quartz. The headframe and shaft appear to be in good condition; however, the shaft is said to have no timber below the 300 level. No other improvements are on the property. The massive mill foundations are a prominent landmark and identify the mine.

The Gold Bar mine, reportedly owned by Mike Chulick of Winters, California, adjoins and is south of the Homestake. This property is similar to the Homestake and apparently is on the same vein. The principal work was done prior to 1908; news items of 1907 mention a 500-foot shaft with 4,861 feet total workings. A 10-stamp mill was installed but its life was short as work was suspended in May 1908. Ransome states, "The Gold Bar lode is a zone of irregularly fissured and brecciated rhyolite fully 100 feet wide. The hanging wall is generally a fairly regular and persistent slip along which some displacement has occurred since the vein was formed. On the footwall side there is no definite boundary between vein matter and more or less disturbed rhyolite. The general strike of the lode near the shaft varies from N. 55° E. to N. 65° E. and the average dip is about 65° NW." The shaft is now open to the 250-foot level with about 1,000 feet of workings on the 150, and 400 feet on the 250; this being about the same work mentioned by Ransome in 1908.

The Mayflower is in what is commonly referred to as the Pioneer district which is here included in the Bullfrog. The area is 10 miles by road northwest of Beatty and is reached by traveling 6.3 miles north of Beatty on the highway and then west. The mine is owned by the Consolidated Mayflower Mining Company of which Mrs. Mary E. Tobin of Goldfield is president. Her husband, W. J. Tobin, operated the mine prior to his death in 1935. W. H. Emmons of the U. S. Geological Survey visited the property in 1906 at which time the inclined shaft was 100 feet deep. Later the shaft was put down to 530 feet and, as per the Mines Handbook (1922), the property had 3,500 feet of workings. It was then reported to have been thoroughly sampled and to have had an estimated 80,000 tons of $10 ore. John Devore of Reno worked at the Mayflower in 1918–1919 during which time a drift on the

500 level was being driven to the Starlight vein. The 15-stamp amalgamation mill, to which a ball mill and more tables were added, was then milling ore from the 200 level. As electric power was no longer available in the district, the mechanical difficulties of stationary power plants plus the marginal value of the ore made the profit of the operation doubtful. The property operated intermittently in a small way until the beginning of World War II. During 1938–1940, S. Bacon installed leaching tanks and worked some of the old tailings; water being obtained from the shaft.

The Mayflower's annual report for the year ending November 1, 1909 is of interest. They milled 3,849 tons of $25.11 ore having a gross value of $68,459. Mill loss was $7.32 per ton, mining cost $9.30 per ton, milling cost $6.98 per ton, leaving a profit of $1.51 per ton. Mill extraction was 70.8 percent. They also mined 1,043 tons of $12.89 ore which was placed on the dump. The company then decided to lease the mine. The geology as summarized by Ransome:[22]

> The lode is a zone of sheeting and shattering which averages from 4 to 5 feet in width. The hanging wall is generally regular and well defined, but the footwall is less definite and the width of the vein in many places is not readily ascertained. It is claimed that the ore is in some places 40 feet wide. The lode appears never to have contained much pyrite and as a rule the valuable constituents are not visible.
>
> Mr. Emmons was informed that considerable bodies of ore averaged $20 a ton, but that the usual grade was from $8 to $12 a ton, nearly all the value being in gold.

Improvements at the Mayflower now consist of a headframe with hoist and hoist house, compressor house, blacksmith shop and ore bin, all in fair condition. One fair camp building is on the property.

The Pioneer mine, owned by the Reorganized Pioneer Mines Company, lies just north of the Mayflower. Activity here started in 1908 with the sinking of a shaft and shipping of ore, one lot of 37¼ tons bringing $4,269. By 1913 a 10-stamp mill had been completed and about 40 tons of reported $10 ore per day was being treated by amalgamation and cyanidation. W. J. Tobin was the managing president of the mine during its early years of operation, later J. K. Turner was designated as engineer in charge.

[22] Op. cit. U. S. Geol. Survey Bull. 407, p. 125.

Probably the most spectacular period in the history of the property was during its first years. The Tobin lease struck high-grade in the latter part of 1908 and is reported to have made its large production in 1909; however, this may not all have been recorded as Couch shows a recorded production of only $44,491 from 2,122 tons, which was made during 1909–1910. It appears that the operation of the Pioneer has been more or less intermittent right up to the present. The last known work was some diamond drill exploration done during the summer of 1949. It is doubtful if any appreciable milling has been done on the property since about 1920. The mill building and several others are on the property; however, the milling equipment has been removed.

The geology of the Pioneer is almost identical to the adjoining Mayflower, that is, the ore occurs in sheared and brecciated rhyolite of various degrees of silicification and alteration. Although high-grade ore is found, its occurrence is very sporadic and the tonnages of this type ore are small.

The latest exploratory efforts on the Pioneer apparently have been with the objective of finding large bodies of the lower-grade ore. This appears to be the best means of developing a future for the property. The shaft is reported to be 800 feet deep and have about 3 miles of workings.

The Indiana group, owned by W. B. Millikin of Denver, Colorado, lies betwen the Mayflower and the Pioneer. Little is known about the property except that it once figured in a law suit with the Pioneer. The activity here was during the boom days of the Pioneer area and it is doubtful if work has been done in many years.

Several other smaller properties are in the Pioneer area. Among them is the Savage group, situated 3 miles west of the Pioneer and owned by the estate of R. J. Kelley of Springdale. Two shafts, one 120 feet and another 100 feet deep, have gone through the rhyolite and penetrated the older quartzites below. The ore is reported to be 30-40 feet wide in a flatly lying attitude between the rhyolite and quartzite and is said to assay about $4 per ton. The work here was done during 1910–1914. No production has been made.

The Toney group of unpatented claims lies between the Pioneer and the highway to the east. The property is owned by William Lahti of Beatty who reports about 500 feet of work on the claims exploring a vein occurring in quartzite. No production has been made from the property.

The Silicates Corporation's unpatented claim in the southeast part of the district, about a mile south of Beatty, was apparently located for kaolin. An adit of about 100-foot length has been driven approximately normal to the highly altered zone of the Amargosa fault. Much of the rhyolite along the fault is completely kaolinized. Ransome describes the fault and shows its structural relationship to the rocks of the area. Quartzites and schists are faulted against the rhyolite in this area. Small sorted shipments are reported to have been made from the property.

The White King bentonite prospect, located by Ben F. Lynn of Beatty, lies a few miles southwest of the town and near the Daylight Pass highway. The owner reports that only minor work has been done on the ground.

Several mills have been built at various times in the Beatty area to treat the Bullfrog ores; often, although not always, these have been custom mills. The obvious reason for this location is the ready water in the Amargosa River; second, the location is readily reached from the Rhyolite vicinity as well as the Pioneer area.

The Quinn mill, reported to have been recently sold to California interests, is west of the Las Vegas highway about 1 mile south of Beatty. This mill has intermittently operated longer than others and is on the oldest custom mill site in the area. A small stamp mill operated here in the early days apparently without success. The present mill has not operated for a year or more but it is understood that the last recovery was made with amalgamation and flotation. Facilities for the leaching of sands are also available.

The U. S. Milling Company built a 100-ton capacity flotation mill in the town of Beatty in 1938 and leased or optioned several properties in the district. The apparent plan, which appears to have been a good one, was to keep the mill going continuously with ore from several properties, thereby not crowding the individual mines and also holding the milling cost down. Just what the difficulties were is not known, however, the company shut down the mill and mines after a rather short period of operation. This mill is still in Beatty and is understood to be intact. It is reportedly owned by Los Angeles interests.

CACTUS SPRINGS

The Cactus Springs mining district includes the north end of the Cactus Range, principally in the vicinity of Cactus Springs and Cactus Peak. It is about 26 miles east by fair desert road from Goldfield and is all within the Tonopah Bombing and Gunnery Range.

Lincoln states that turquoise was discovered here in 1901 and silver in 1904. Although the district has seen much activity in the past, and several properties have had an appreciable amount of work done, only a very small production has come from here. It is doubtful that the total district production would exceed $20,000.

Geology. S. H. Ball[23] in discussing the general geology of the Cactus Range states, "The succession of formations exposed in this range, from the base up, is as follows: Pogonip limestone (Ordovician), Eureka quartzite (Ordovician), Weber conglomerate (Carboniferous), granite, diorite porphyry, hornblende-biotite latite, earlier rhyolite, biotite andesite, augite andesite, later tuffs(?), later rhyolite(?), and basalt." The greater part of the surface is covered by Tertiary Miocene rhyolite.

Gold and silver are the principal economic metals with some copper also occurring in the area. The ores are found in quartz veins and stringers, usually in kaolinized or silicified rhyolite. The larger veins are 2 to 4 feet wide. The mineral turqouise occurs in sheared rhyolite and is reported to be of economic importance in the area.

Properties. The Silver Sulphide group of unpatented claims, owned by Edith F. Bailey of San Bernardino, California, and others, lies about 1 mile south of Cactus Springs. It is believed that this property was also known as the Cactus Silver mine and was operated by a company of that name in about 1920. It is reported that the company made a small production.

The ore occurs in numerous quartz veins and stringers in rhyolite, the values being principally in silver with small quantities of gold in some of the ore.

The principal working is said to be a 265-foot vertical shaft with about 800 feet of levels. Water stands at 130 feet. In addition, the claims have several shallow shafts and open cuts.

The Thompson group of unpatented claims, owned by Leonard Thompson and others, lies on the southwest slope of Cactus Peak. A 230-foot shaft, nearly filled with water, and several more shallow shafts and other workings have explored quartz veins in rhyolite. The values are principally in gold and silver; however, turquoise has also been mined here from shallow cuts in the rhyolite. It is reported that the property has made some production of the gem material.

[23] Op. cit. U. S. Geol. Survey Bull. 308, p. 89.

The Adolph Neher adit, on property of unknown ownership, is situated in the eastern part of the district about 1 mile east of Cactus Springs. It is outstanding in that the adit, over 1,000 feet in length, and driven by Neher prior to the last war, reportedly has little ore indication either inside or on the dump.

CLIFFORD

The Clifford district is about 50 miles east of Tonopah and 1 mile south of the Tonopah-Ely highway. The district was discovered in the spring of 1906[24] by James and Ed Clifford who did much of the early work. At one time the camp had a post office, hotel, store, and a population of 500. In 1907 the name was changed to Helena; however, it soon must have been changed back as all other accounts of the district refer to the original name. Couch shows no recorded production for the camp; however, it is said to have produced over $500,000.[25]

Geology. The district occupies a small hill, jutting out of the valley, near the west side of the north end of the Kawich Range. Henry G. Ferguson[26] in describing the district states:

> The greater part of the small hill is composed of thin-bedded rhyolitic sandstone and pyroclastic rocks, rhyolitic tuff, and breccia. Andesite similar to that of Golden Arrow occupies the extreme western point of the hill. Although no clear contact was seen, it seems most probable that the andesite is not intrusive into the pyroclastic rocks, for in some of the specimens collected there are pebbles of a much altered andesitic lava inclosed in a matrix of fine-grained quartz fragments.
>
> The ore of the shallow workings consists of heavily iron-stained tuff cut by small quartz veins that contain small irregular masses of limonite. Close examination of the richer ore reveals cerargyrite, mostly stained brown by iron oxide but in part light green, and a few minute threads of native silver. In the specimens examined microscopically the cerargyrite grains occur in minute veinlets of light-brown jarosite. Rare specks of a silver sulphide mineral and pyrite, the latter surrounded and partly replaced by jarosite, were seen in the oxidized ore. A small amount of free gold of a light-yellow color is present in concentrates obtained by panning the richer ore.

[24] Sawyer, B. F. W., op. cit., p. 104.

[25] Weed, W. H., op. cit., p. 1406, 1931.

[26] Ferguson, H. G., The Golden Arrow, Clifford, and Ellendale Districts, Nye County, Nevada: U. S. Geol. Survey Bull. 640-F, p. 121, 1916.

Properties. The Clifford mine is the only property in the district. It is owned by the Western Gold Corporation, represented by W. B. Naismith of Tonopah. The property came into the present ownership in 1925 and was operated intermittently by the company and lessees until 1946.[27] Mineral Resources reports the shipment of 260 tons of ore containing 2 ounces gold and 4 ounces silver per ton from Clifford to the Millers mill in 1930. In 1941 and 1946, part of the dumps were shipped to a smelter. The property has been idle since 1946.

The workings consist of two vertical shafts, one 300 feet deep, the other 400 feet in depth. Both have headframes and one has a hoist. Water stands at the 300-foot level in the deeper shaft.

E. M. Booth of Tonopah was one of the last successful lessees at the property. He states that the ore zone is 100-125 feet by 70 feet and the ore occurs in this zone as pipes and bunches. Although the values are usually in silver as the chloride, some high-grade bunches of gold ore have also been found.

CLOVERDALE (Black Springs, Golden, Republic)

The Cloverdale district includes the southern part of the Shoshone Mountains from the Cloverdale Ranch at the southern tip to about 8 miles north, including both East and West Golden. The district also includes the area near the Orizaba mine, which is on a spur off the northern Cedar Mountains and is about 5 miles air line southwest of the Cloverdale Ranch.

The district is about 40 miles by road from either Tonopah or Mina. Condition of the routes depends on the part of the district; from East Golden and Cloverdale the route to Tonopah is usually preferred, while from the Orizaba section the Mina road is ordinarily in better condition. Water may be obtained from several springs in the area usually within a short distance of the properties. The California Electric Company's line to Gabbs passes between the Cloverdale Ranch and the Orizaba mine and is therefore within a short distance of the mining properties.

Geology. Tertiary volcanics cover all of the southern part of the Shoshone Mountains and much of that part of the Cedar Mountains included in the district. Triassic limestone and dolomite of the Luning formation[28] is exposed over a large area of the

[27] W. B. Naismith, personal interview.

[28] Ferguson, Henry G. and Muller, Siemon W., Structural Geology of the Hawthorne and Tonopah Quadrangles, Nevada: U. S. Geol. Survey Prof. Paper 216, plate 1.

western part of the range and is the host for the silver occurrences at Orizaba and Republic 2 miles north. Triassic chert of the Excelsior formation, which underlies the limestone, is found about 5 miles south of the Orizaba. The chert is host for an important occurrence of turquoise.

At East Golden, about 8 miles north of the Cloverdale Ranch gold is found in brecciated rhyolite. Gold, apparently derived from this deposit, has formed the placer on Cloverdale Creek below East Golden. Hillside placers are also found in the area.

West Golden is just west over the ridge from East Golden. Here, gold occurs in narrow veins and placer deposits similarly to those to the east.

Properties. The Republic area is in the extreme northwestern part of the district. Two properties have been worked in this area. One owned by Tom Hyland and others, of Tonopah, has a 200-foot shaft in rhyolite. Several laterals have been driven but very little stoping has been done. The vein is 1-2 feet wide and has some good-grade silver ore. Two samples of the better appearing ore contained 8 and 22 ounces silver per ton.

William Farris of Tonopah has a silver-lead property about one-half mile west of the Hyland ground. Argentiferous galena occurs here in a narrow vein dipping 40° S. with the hillside. A cross-cut adit gives access to the vein which has been stoped to the surface. A raise driven to the surface from the vein was used in the last work in 1949 during which, 12 tons of ore containing 40 ounces silver per ton were shipped by Dunsdon and Cornell.

Republic has several buildings in fair or better condition and a shallow well furnishes domestic water.

The Orizaba or Green Metals mine lies about 1 mile air line south of Republic and 2 miles west of the power line to Gabbs. The property is owned principally by the estate of Lou Miller, with C. C. Boak and John Connolly, of Tonopah, as co-administrators of the estate. Mr. Boak states that the total production to date is $127,980 from 3,127 tons, or a value of $41 per ton.

A report[29] made by John Dynan, presumed to have been written in the early twenties, states:

> Mr. P. V. Rovnianek (operator of the mine) informs me that before he took over the mine there had been shipped to smelters 500 tons assaying about $100.00 per ton. Since that time there has been shipped (1913–1918) 527 tons of $22,980.00 gross value, or $43.22 per ton. These figures are from smelter returns, duplicates of which are in my possession. The average price received for silver in all the ores shipped has been about $0.70 per ounce.

[29]Copy in possession of C. C. Boak.

Dynan reports that the vein occurs in limestone near a granite contact. The strike is northwesterly and the dip is 60° to 80° SW. The inclined shaft is 145 feet deep with levels at 65 feet and 83 feet. Dynan adds that after his examination, letters from Rovnianek state that from a point 110 feet west of the shaft on the 83-foot level, a 65-foot winze was sunk on the vein. Drifts were run 25 feet westerly and 15 feet easterly with the vein quartz said to assay about 40 ounces silver per ton. These letters also stated that the bottom of the shaft was in the footwall and cuttings from long-hole drilling to the vein assayed 12 ounces silver per ton. With the water level just above the 83-foot level, pumping 75 gallons of water per minute with steam driven pumps was very costly and unreliable. Boak states that all ore exposed by the development work, above the water level, has been stoped.

Although most of the Orizaba ore has been oxidized, Dynan states that several bunches of sulfide minerals containing argentite, galena, and sphalarite were found on the 83-foot level. The zinc content of the ore could normally be expected to increase appreciably below the water table.

Director Jay A. Carpenter inspected this property in November 1945. Water stood on the 83-foot level. A picked sample of sulfide ore taken at the collar of the winze assayed 0.06 ounces gold and 50.5 ounces silver per ton. A 6-foot cut sample from a pillar of oxidized ore on the 65-foot level assayed 0.03 ounces gold and 37.4 ounces silver per ton. Professor Smyth's cyanide test on this oxidized ore at minus 80 mesh gave a 95.7 percent extraction.

The Orizaba was last worked in 1949 by Hubert Welch who shipped 44 tons of ore containing 11 ounces silver per ton. The hoist house, with single-cylinder gasoline hoist, and an old boiler house are still on the property and in fair condition. A spring and two good houses are about one-half mile from the mine.

The Blue Gem turquoise mine is south of the Orizaba and 3 miles west of a point on the California Electric Company power line, 5 miles south of the branch road to the Orizaba mine. The mine is owned by Bert King of Gallup, New Mexico. Louis Cirac of Tonopah discovered the property in 1914 and sold it to Lee Hand who mined turquoise for several years. Other turquoise miners have also owned the ground and it may be assumed that considerable gem material has been mined here. The workings

are in the steepest part of the area just below cliffs that terminate at an altitude of 6,400 feet.

The turquoise here occurs in chert similarly to the Royston deposits to the south. Mining has been done in large cuts and in a glory hole with adit. The workings cover a zone about 150 feet in length and are 500 feet up a steep hillside from the end of the road.

Improvements consist of a building at the mine, housing a sorting table, and a cabin for living quarters on the road. Water must be hauled to the property.

The East Golden mine, comprising 10 unpatented lode claims and owned by Barney Francisco who lives on the property, is situated on the east slope of the Shoshone Range at an estimated 6,500 foot elevation. It is 7 miles north of Cloverdale and one-half mile west of the Cloverdale road. Gold was discovered here by an Indian in about 1902, but it appears that no mining was done until much later. In the twenties, Francisco equipped the property with a homemade tube mill but found that recovery was poor. In 1941, lessees installed a 3½-foot Huntington mill complete with crusher plates and concentrating table. It is reported that this mill, which is still on the property, was also a failure. Milling water was obtained from a well in the wash adjacent to the mill. Aside from the trial milling, a few small ore shipments were made; however, no production is recorded. The gold ore occurs in shear zones in Tertiary rhyolite, and it is reported that one zone 18 to 36 inches wide and 100 feet long assays $20 to $30. O. J. Belleville of Mina did some exploratory work and sampled the property in 1932. He states that the ore must be cyanided; however, his results did not warrant the installation of a cyanide mill at that time. The workings consist of three adits totaling 1,500 feet which the owner claims expose three veins containing ore ranging from $20 to $90 per ton if selectively mined. It appears that future operators will either have to mine ore of shipping grade or change the present milling plan.

The Cloverdale gold placers are on Cloverdale Creek below East Golden. It is reported[30] that gold was discovered here in 1906 and that in 1931 a company prospected the canyon with 26 shafts 20–50 feet deep. It is said that some churn drilling was attempted

[30]Vanderburg, W. O., Placer Mining in Nevada: Univ. of Nev. Bull., Vol. XXX, No. 4, pp. 122-3, May 15, 1936.

in later years. The ground is principally owned by the estate of Lou Miller, administered by C. C. Boak and John Connolly of Tonopah.

The West Golden placer claims are owned by the Peruchietti family of Tonopah who have done some prospecting on the ground but have been hampered by the flow of water on bedrock. They state that they were encouraged by the results obtained in test pits but did not have the equipment to cope with the water and were forced to abandon the work.

Lincoln states that, at the time of his writing, diatomaceous earth was being mined near Black Spring northwest of the Cloverdale ranch and used in the manufacture of tooth paste and powder. No more recent activity has been noted at this deposit, although much exploration by trenching has been done in recent years on deposits of diatomaceous earth in Mineral County a few miles to the west. Lincoln gives an analysis of the material at Black Spring which shows a content of 84.39 percent silica and 10.91 percent loss on ignition.

CURRANT (Butterfield Marsh, Railroad Valley Marsh, Silverton)

The Currant mining district lies in the vicinity of Currant on the Ely-Tonopah highway, 52 miles southwest of Ely, or 116 miles northeast of Tonopah. Lincoln mentions a little activity in the area in 1914 and 1916, however, it appears that most of the small production from the district came much later. Couch shows a recorded production of $4,278 from 590 tons in 1940. This was made by the Currant Creek Mining Company and it is assumed that the ore came from what is now known as the Gold Bearing Ledge group. In addition to the recorded production, it is known that some ore was shipped without public record being made.

Geology. The principal ranges in the district are the White Pine and Grant which are separated only by low rolling hills of volcanics and young sediments near and south of Currant. Paleozic sediments intruded by granitics and overlain by tertiary volcanics and sediments are found in both ranges. Gold occurrences found in the White Pine Range are in the older sediments. To the south, radioactivity has been noted in tertiary (?) sandstone and conglomerate and in a shear zone in the overlying rhyolitic tuff and latite.

The Silverton area is 28 miles southwest of Currant in the Pancake Range. Here, silver ore is reportedly found in Pennsylvanian (?) limestone intruded by rhyolite dikes and sills. The vicin-

ity is capped by more basic volcanics that appear to be quite young and are assumed to be Miocene (?). The upper flows observed are basalts.

Butterfield Marsh, which lies between the Grant and Pancake ranges, contains lake sediments having extensive beds of gaylussite, a combination of sodium and calcium carbonate.

Properties. The Gold Bearing Ledge group, owned by George Bogdanovich of Ely, lies on the west slope of White Pine Mountains about 5 miles northeast of Currant and is easily accessible by one-half mile of dirt road from the Ely highway. The property was examined by Fred L. Humphrey in July 1949. His report, which is the source of the data in this description, is on file in the Bureau office. He states that several cars of "good" ore reportedly have been shipped, however, actual values are not known. Samples taken indicated sorted ore to assay $27 and dump rock from the same excavation to assay $6.30 per ton. The values are in gold which occurs in a brecciated chert bed in and near a prominent fault zone along a quartz latite dike. Limestone and shale overlie the chert. Humphrey believes the faulting to be such that a large segment of the brecciated chert has been faulted down 300–500 feet below the present outcrop. Workings consist of several cuts exploring the outcropping segment of the chert and four adits which, if the hypothesis of a downfaulted segment is correct, are several hundred feet above the ore and of no value. Humphrey concludes that the property is worthy of further exploration in the region of past production and an effort should be made to delimit the possibility of the downfaulted segment.

The Ala-Mar magnesite property, well described by G. H. Holmes, Jr., and E. J. Matson[31], is near the crest of the White Pine Range about 3 miles airline north of the Tonopah-Ely highway. Although commonly referred to as being in Nye County, Holmes' and Matson's report shows nearly all the deposit to be in White Pine County.

The Thor group, recently located by B. F. and Frank Roberts and Don Lani of Duckwater, lies southeast and just outside the fenced property at Currant. A north bearing fault zone in a latite which overlies a rhyolitic tuff has relatively strong radioactivity. The owners have sunk a shallow shaft and have done other surface prospecting in an effort to follow the zone of radioactivity. Ordinarily the best response on the Geiger-Mueller counter is obtained from the very smooth fault faces. No uranium bearing mineral

[31]Investigation of the Magnesite Deposit of the Ala-Mar Magnesium Co., Inc., and Nevada Magnesite Co., White Pine County, Nevada. U. S. Bureau of Mines. Report of Investigation 4608.

was identified. The latite and tuff are believed to be underlain by a Tertiary (?) sandstone and conglomerate found about a mile southeast. A little radioactivity was found in some areas of these sediments and a group of claims was located by the same parties. The beds have a general northerly strike and dip about 50° E.

A deposit, termed both alunite and kaolinite is situated near Currant, one-half mile off the Ely highway. The property consists of 12 claims and is owned by the A. & O. Company of Beverly Hills, California. The owners report that some years ago several carloads of the material were shipped to a pottery manufacturer in St. Louis. Exploration reportedly has been by a short adit and several test holes. The owners have had several chemical analyses made in an effort to determine a possible use for the material. These analyses indicate the material to be an impure kaolinite containing some alunite.

The Silverton Mines group of about 40 claims, owned by the Tognoni family of Eureka, lies in the Pancake Range, 28 miles southwest of Currant. The group is about one-half mile north of the Tonopah-Ely highway. Silver ore was discovered here by J. C. Tognoni in about 1921. A company was immediately organized, a shaft was sunk, high-grade stringers mined, and the ore shipped to Tonopah. This advertised the area, but little production was made.

Hale C. Tognoni, who has the Silverton claims under agreement, states that small shipments of ore carrying 10 to 30 ounces of silver per ton were shipped during 1930–1937. He believes that a large scale geologic exploration program is necessary to gain information for the possible development of important ore bodies. He states that the silver occurs as argentite, cerargyrite, and native silver in small veinlets in Pennsylvanian (?) limestone near rhyolite dikes and sills. The workings consist of a 100-foot vertical shaft, four or five adits up to 200 feet in length, and many shallow shafts. The main shaft has a headframe and hoist house.

Butterfield Marsh is often regarded as a separate mining district; however, it is here included with the Currant district due to its proximity. Lincoln's description of the area summarizes it well. He states, "Railroad Valley is a typical desert basin extending for 100 miles in a north-south direction and having a width of from 10 to 20 miles. Its drainage area is about 6,000 square miles and the flat central portion has an area of 200 square miles. Butterfield Marsh is in the lowest portion of the valley and has an area of 40 square miles. The valley was formerly occupied by a lake whose level was from 50 to 300 feet above that

of the playa. Butterfield Marsh is commonly covered with a thin crust of salt and toward its north end are irregular salt pans where the salt incrustation is thicker, and from which the production has come. Potash occurs in these efflorescences but drilling by the Railroad Valley Company failed to disclose any potash salts in depth although soda-bearing beds consisting chiefly of gaylussite, hydrous sodium-calcium carbonate, were encountered." Lincoln's mention of salt production refers to that which was mined in the early days for the mills at Tybo.

The Railroad Valley Company made a comprehensive study of the district and drilled seven holes of 745- to 1,204-foot depth. The work was carried out during 1912–1914 at a reported cost of $150,000. An excellent article by E. E. Free[32], consulting geologist for the company, in addition to other news items[33], gives a fair description of the drilling and results. He states that gaylussite was encountered in three holes with one hole penetrating 194 feet and another, 127 feet of the mineral. As the company was in search of potash minerals, which due to their greater solubility would be expected at a higher horizon, none of the holes were drilled through the gaylussite beds.

The probable huge tonnage of almost pure mineral and the recent demand for sodium carbonate has attracted considerable attention to this deposit. This interest is in spite of the unfavorable location and the problem of rejection of the calcium carbonate. In addition to the good grade gaylussite, there is a large surface area of mixed gaylussite and clay.

DANVILLE

The Danville district is about 95 miles northeast of Tonopah and 55 miles north of the old Five Mile Station on the Tonopah-Ely highway. Although distant from supply centers the roads are in good condition. The district is on and near Danville Creek on the east flank of the Monitor Range, 3 miles west of the Little Fish Lake Valley road. Water enough for any mining use likely in the area is found in Danville Creek which rises from springs on one of the unpatented claims. It is estimated that the elevation ranges from 7,000 to 7,500 feet in the principal mineralized area. Snow conditions are such that some snow removal equipment would be necessary for any contemplated winter operation.

Thompson and West state that the district was discovered in 1866 by P. W. Mansfield and reorganized in 1870. Couch shows a recorded production of $4,747 from 31 tons during 1866–1891.

[32]Mining and Scientific Press, August 2, 1913, 176-178.
[33]Idem., Feb. 14, 1914, 314; April 4, 1914, 591; May 16, 1914, 797.

In the 1944–1945 period $26,465 was produced from 3,846 tons, probably from dumps. The value of the ore is principally in silver with little or no gold. Without doubt, much production has not been recorded as Joe Clifford states that he recalls wagon shipments from Danville stopping at Stone Cabin approximately during 1909–1914.

Geology. The sediments here, believed to be Silurian(?), are principally various limestones underlain by shales and capped by Tertiary rhyolite and latite. The known ore deposits are in shear zones in limestone just west of the volcanics which cover the lower elevations of the range. The known mineralized area is about 1 mile across, although some minor work has been done well outside this area.

All the ore noted occurs in shear zones as veinlets and small irregular replacement bodies. In the southern part of the district the ore contains a highly argentiferous galena, while in the northern part the silver minerals usually occur without the galena. No appreciable quantity of gold is found in the ore.

One very prominent fault zone known as the Vestal Shear bears about S. 30° E. and may be seen for nearly a mile. Minor exploration has been done along the full length of the shear and some ore has been found in drift-adits near Danville Creek. That portion south of Danville Creek is more precipitous and is not accessible by road; therefore, less work has been done here.

No definite district pattern of the shear zones was noted although localized areas usually have a characteristic trend. The workings on the north side of Danville Creek, and several hundred feet from the Vestal Shear, show a general northeast strike. In the next canyon north of Danville Creek the shearing is generally northwest.

Properties. Seven and a fraction claims, all patented, cover the known ore occurrences in the district and are owned by Jack Ekstrom who lives at the old camp of Danville. In 1949 he shipped 70 tons, which averaged about 17 ounces silver per ton, coming from the dump of the Boston claim that reportedly was last worked in 1934 by the Continental Mines Company of Denver. They sank a 125-foot shaft and attempted to find the continuation of ore mined from nearby caved workings, but their objective was not reached.

The principal workings are just north of Danville Creek. An estimated thousand feet of work and much stoping has been done on a highly silicified shear zone. The dump from this work is reported to carry about 14 ounces silver per ton. Some screening

of the dump material has been done, but the results are believed to have been unsatisfactory.

Generally the ore zones in the district are about 1 to 4 feet wide, usually being of narrow width, and the ore is rather spotty. Near-surface enriched silver ores have been rather high grade in spots and it is reasonable to believe that further prospecting will find more of these deposits. Parallel veins are very common in the vicinity of the ore occurrences.

The King Solomon antimony prospect owned by Woodrow Peterson is in the Monitor Range 38 miles by road north of a point on the Tonopah-Ely highway 30 miles east of Tonopah. It is 3 miles northwest of the old Kelsey Ranch on Willow Creek. M. F. and Lorena Peterson discovered antimony here in 1936 and in recent years made an unsuccessful attempt to roast the ore and extract antimony trioxide. It appears that about 10 tons of ore was roasted. The stibnite, with small amounts of the oxide, occurs with calcite in stringers and shear zones in a porphyritic rhyolite having a high quartz content. The rhyolite is highly kaolinized near the ore occurrences. The workings consist of a 30-foot shaft, several large cuts and about 1,000 feet of bulldozer and handmade trenches. This work was done in hope of developing a large mill-grade deposit. The property is about 15 miles air line southwest of Danville proper which is the nearest recognized district in the Monitor Range.

EDEN (Eden Creek, Gold Belt)

The Eden mining district is about 70 miles east of Tonopah, or 21 miles south of Warm Springs, on the Tonopah-Ely highway. The last 7 miles of the road gets very little travel and is now nearly impassable. The district lies on the east side of the Kawich Range at about 7,000 to 8,000 feet elevation. Weather conditions are such that year-around mining operations are feasible. Water for domestic purposes and for the operation of small mills has been obtained from some of the several springs in the area.

Ball credits John Adams with the first locations early in 1905. It is reported that lessors working near the mouth of Eden Creek, formerly known as Little Mill creek, made some shipments from the district in 1906 and 1907. The uprights and mortar block of an old five-stamp mill were noticed below the mouth of the canyon. Since the early days the district has been worked intermittently and the activity has moved up the canyons to the west. No production has been recorded from the district; however, it may be assumed that the total is something less than $10,000. No work has been done in the district for many years, the claims being held by reason of the moratorium on assessment work.

Geology. Tertriary volcanics, principally rhyolitic, are the only formations mentioned or noticed in the area. As mentioned by Ball, silicified zones in rhyolite stand out and are commonly referred to as dikes. The ore occurs in shear zones which are either partly or completely replaced with quartz. Although the mineralization in most of the district was predominantly gold, some veins carry more silver and a trace of copper is often found in the ore.

Properties. The Nevada Triumph group of 17 claims owned by the estate of George H. Chubey is 3 miles southwest of the Eden Ranch at an elevation of about 7,000 feet. The claims were first located in 1926 and were worked by the locator until his death; since then the estate has held the claims through the provisions of the assessment work moratorium. A publicized strike of "picture rock" was made by the owner in 1929; however, it was probably a rather small pocket as the property has no known production. The values are principally in gold which occurs in iron-stained silicified shear zones in the rhyolite. Values vary considerably but are usually low. The property is reported to have some potentialities for the development of a large low-grade deposit. The workings consist of two adits having a total of about 300 feet of laterals with three winzes from 35 to 50 feet in depth, several shallow shafts, and cuts and trenches.

The property of the South Gold Mining Company, controlled by the C. R. Terrell estate of Tonopah, is at an approximate elevation of 8,000 feet. The first work was done in about 1930 and continued until World War II. It is reported that the total production has been about $5,000, part of this being recovered as placer gold. Much of the overburden is said to carry gold values. The mineralization is gold with little or no silver occurring in veins and shear zones in rhyolite. The owners claim to have wide ore zones exposed on the surface and underground that assay from $3 to $5 per ton. The ground is opened by a 1000-foot adit caved at the portal, a 500-foot adit, and a 300-foot adit with a 50-foot winze; the latter workings are both open. A 35-ton mill installed in about 1938 is on the property and consists of a jaw crusher, a 3-foot screen discharge mill, impact amalgamator, and a Diester concentrating table, all powered by a 45-horse power Diesel engine. Only about 200 tons of rock has been milled and all equipment appears to be in excellent condition. The ore was

transported to mill down a steep slope by a gravity tram, now partly removed. The camp near the mill consists of about 12 buildings in various stages of disrepair. Water is piped from a spring just above the camp.

The Oro Cache Mining and Milling Company property, controlled by Mrs. Harriet Stingley of Tonopah, is 5 miles westerly of the Eden Creek ranch, at an approximate elevation of 8,000 feet. The claims are west of the South Gold mill. The company was organized in 1929 and explored the ground until 1934, when the closing of the banks curtailed financing. No production has been made from the property. The gold mineralization, which is reported to be entirely free milling, occurs in veins and shear zones in rhyolite. A list of assays, reportedly representing samples taken during exploration, vary from $2 to $250 with a large percentage grouped between $10 and $70. The workings consist of a 50-foot shaft with 72 feet of drifting from two levels, a 218-foot adit cutting and drifting on the same vein about 50 feet below the shaft, and several shallow shafts and trenches. Improvements are a one-room house built near a spring and a cellar. Although the values occur rather sporadically, the assays available indicate that the property is worthy of further investigation.

The Golden Crown group, also known as the old Eden mine, is owned by the G. B. Fallini estate and lies 2 miles west of the Eden Creek ranch on the road to the Oro Cache and South Gold properties. It is reported that silver ore was discovered here in 1906 and that much work was done during 1923–1924. The principal workings are said to consist of two adits, the upper is 500 feet in length and the lower 1,700 feet long. Both adits are said to have track. Rock found on the upper dump showed quartz seams containing pyrite. The country rock is largely rhyolite intruded by porphyritic andesite. It appears that very little has been done here since 1924 although the ground was leased in 1935.

ELLENDALE

The Ellendale district is 31 miles east of Tonopah and 2 miles south of the Tonopah-Ely highway. It lies at an approximate altitude of 6,000 feet, in the hills of the southern end of the Monitor Range overlooking the Ralston Valley to the southwest. The nearest water is obtained from wells in Salisbury Wash, near the highway, about 2 miles north of the district.

High-grade float was discovered here by Ellen (Clifford) Nay on April 1, 1909. The property was worked by the Clifford brothers and Joe Nay, and by 1915 had produced much fabulous high-grade gold ore. The production, estimated by Mrs. Mary Dahlstrom of Tonopah and Joe Clifford of Stone Cabin, was one million, and one-half million dollars, respectively. Couch shows a total recorded production from the district, to and including 1948, of $166,015 from 18,245 tons. Of this amount, $70,050 from 5,533 tons came from the Ellendale mine.

Henry G. Ferguson[34] describes the strike:

> The deserted district of Ellendale lies on the road between Tonopah and Stone Cabin, a few miles east of Tonopah. The claims were located a few years ago, and the rich surface showings started a rush which was a miniature repetition of those following the discovery of such camps as Tonopah, Goldfield, and Manhattan. A town was laid out and houses were built, but today a single empty house marks the site of the town. The extent of the older workings is considerable, but apparently only a very small amount of ore was of sufficiently high grade to be shipped. In 1910 there was shipped from the district 25 tons of ore containing $18,349 in gold and 718 ounces of silver valued in all at $18,737, or $720.65 a ton.[35] In 1911, 94 tons was shipped, carrying $54,702 in gold and 1,823 ounces of silver, with a total value of $55,668, or $592.21 a ton.[36]

It may be assumed that neither Ferguson's figures for the 2 years nor Couch's recorded state figures show the total production made. Lessee production is frequently not shown. Joe Clifford of Stone Cabin states that he had a lease on the property in the early days and was able to start in the ranching business on what he made from his lease. This and possibly other unrecorded lease production could account for a large part of the estimated production.

Geology. Ferguson describes this fully:

> Most of the workings are in rhyolite, near the contact of andesite porphyry. The rhyolite is fine grained and rather siliceous and carries small phenocrysts of quartz and feldspar. Biotite in rare and minute plates is the only ferromagnesian mineral present. The andesite is similar to that of Clifford and Golden Arrow, but the relations of the two rocks could not be determined.

[34] Ferguson, H. G., The Golden Arrow, Clifford, and Ellendale Districts, Nevada: U. S. Geol. Survey Bull. 640-F, pp. 122-123, 1916.
[35] U. S. Geol. Survey Mineral Resources, 1910, pt. 1, p. 525, 1911.
[36] Idem, 1911, pt. 1, p. 689, 1912.

So far as a very hasty inspection showed, no mining of any importance had been undertaken in the andesite area.

The mineralization consists in the irregular veining of the rhyolite by numerous little fissures filled with iron-stained quartz and the silicification and to a less degree the sericitization of the adjacent rock. The rhyolite in the mineralized zone also shows numerous brown specks, resulting from the alteration of pyrite. Microscopic examination of the ore shows that these rusty specks are composed in part of jarosite. The silicified rhyolite is also cut by minute veinlets of jarosite, few of which exceed 0.1 millimeter in width. It appears that the oxidation of the pyrite in conjunction with the weathering of a potassic rock has resulted in the formation of the sulphate jarosite instead of merely the hydrous oxide limonite.

A few miles southwest of the gold workings is a flatly lying sheeted material which appears to be a rhyolitic sandstone similar to that described by Ferguson and quoted herein under the Clifford district. The sandstone(?) is extremely fine grained and has been beautifully iron-stained by differential alteration. The beds are of unknown thickness but exposed by mining for about 20 feet. They are overlain by volcanics.

Properties. The Ellendale mine is owned by the heirs of Ed and John Clifford and Ellen and Joe Nay. Of these, the principal shareholders are Mrs. E. W. King of Fallon, Mrs. Mary Dahlstrom of Tonopah, and Mrs. Emma Walch. The main workings, which consist of a glory hole with several adits and shafts, are on the west side of a hill overlooking Salisbury Wash. Most of the work was done here during 1909–1915. The only recorded production in late years was made by the Gilbert brothers in 1938–1939. They sorted and shipped 357 tons, from the dumps, that had a gross value of $7,215.

The Imperial group, owned by Jack Clark of Tonopah, adjoins the Ellendale mine. Workings reportedly consist of three 50-foot shafts and other shallow workings in a silicified and altered rhyolite and andesite. Little has been done here for many years and it is assumed that the original work was on ore having a surface concentration of gold.

Much work has been done in the district on other gold prospects; however, most, if not all, of these claims have been abandoned and very little seems to be known about them.

The Painted Chief claim, owned by Frank Trueba and Charles Joseph of Tonopah, lies a few miles south of McKinney tanks on the southwest flank of the Monitor Range. The property is 21 miles east of Tonopah by road. An iron-stained sandstone(?) mined here by Frank Smith of Palmdale, California, is used as a decorative stone. It has been used for store fronts and is said to be excellent for this purpose. John L. James and others have claims adjoining the Painted Chief on the same bed of material; however, no production has been made from these claims.

The Glidden Paint Company's patented barite claim lies about 5 miles east of the Ellendale mine and is 36 miles east of Tonopah. The company periodically mines this barite of superior quality, depending on its requirements. Couch shows 16,070 tons mined during 1939–1949 at a declared value of $112,500.

Sedimentaries exposed here underlie the volcanics found to the west. The beds strike northwest and dip 50° SW. The barite appears to be a replacement of a limestone bed about 30 feet wide as exposed in the open pit which is about 40 feet wide by 160 feet long and 25 feet deep. The limestone bed is underlain by a quartzite interbedded with shale. The deposit occurs in an area of slight relief in which the overburden is often 6 feet or more in depth, therefore, prospecting for the continuation of the barite must be done by drilling.

FAIRPLAY (Atwood, Goldyke, Paradise Peak)

The Fairplay district lies at the south end of the Paradise Range about 10 miles due south of the Gabbs area. In the Atwood-Goldyke area, elevations range from 6,000 to 6,500 feet and winter weather conditions are usually not severe. Although water is not plentiful two good springs were found, the best is at Goldyke or the Tom Burns camp at the south extremity of the district and the other is at the Okey Davis mine camp 2 miles north. The Paradise Peak area is about 5 miles northeast of Goldyke at elevations ranging to 8,500 feet. Due to the higher elevations, winter weather conditions are relatively more severe and springs are more plentiful. Fair dirt roads connect the district with Gabbs, Mina, and Tonopah.

As per articles in old copies of Engineering and Mining Journal, the district was discovered in about 1901 and first organized as Atwood. Although no production is recorded with the County or State, Mineral Resources shows an intermittent small production from 1907 to 1930. Gold, silver, and mercury are apparently the principal economic metals; however, some lead and copper have also been produced.

Geology. The rocks in the main part of the Fairplay district are Tertiary latite and andesite which have been intruded by rhyolitic dikes. The mineralized zones are usually in near proximity to these intrusions. The economic metals here are gold and silver with some lead occurring in quartz veins and shear zones. At the Butler, which probably has had the only appreciable gold and silver production in the district, the ore occurs in quartz veins. In the Paradise Peak area the rocks are Mesozoic sediments that have been intruded by a granitic rock, probably quartz monzonite. Cinnabar associated with scheelite at the Scheebar mine is the principal ore occurrence although some copper and lead prospects have been reported on the west side of Paradise Peak and may be the source of a small production in these metals reported from the district.

Properties. The old Butler mine is situated on the top of a north-south ridge in the eastern part of the district. It may be identified by an old four-post type headframe and its 45° inclined shaft, both of which are in rather poor condition. It is said that this property has had the principal gold and silver production in the district; however, none is on record. The values here are reported to be found in vein quartz 2–10 feet wide on either side of a rhyolite dike 20–100 feet wide. The shaft is 280 feet in depth with 150–, 225–, and 280–foot levels. It is reported that sporadic gold and silver values may be found on the 150–foot level.

What is commonly referred to as the Okey Davis mine, now owned by Gene Perry of Mina, is 2.8 miles north of Goldyke on the same ridge as the Butler mine about one-half mile south. The Davis camp is down the east side of the ridge, one-quarter mile from the mine. This property was operated by the Oatman United Gold Mining Company in the late twenties, which company did much exploration and built a camp containing about eight buildings. The buildings still stand but are in poor condition due to lack of repair. The property has a vertical shaft which The Mines Handbook (1931) states goes to a 300–foot depth and has opened mill ore on the 50–, 100–, and 200–foot levels. The rock here is andesite intruded by a large rhyolite dike which appears to be the same dike found at the Butler mine and may also be the one found at the Jim at Goldyke. The property has had no known production. The headframe and shaft are in good condition, but other improvements were stripped in recent years. From evidence of pumping equipment, some water was encountered in the shaft.

The Jim group owned by Tom Burns of Goldyke is situated in the southern part of the district adjacent to the site of the town of Goldyke. Apparently no production has been made; however, much work has been done on the claims. Exploration consists of a 140–foot shaft, several shallow shafts, and many surface cuts and pits. The rock here is andesite which has been intruded by a fine-grained rhyolite dike. Most of the prospecting has been done between this dike and a parallel shear zone about 200 feet southwest that bears S. 25° E. and dips 60° SW. Some galena is found, occurring sporadically in quartz veins in the andesite which has undergone intense hydrothermal alteration in much of this area. All the shallow workings are open and accessible; however, the collar of the 140–foot shaft is caved. One building at the old camp of Goldyke is in fair condition, and the remains of an old 5-stamp amalgamation and gravity concentration mill stand just below the camp. The best spring in the district is here; however, it flows only enough water to intermittently operate a small mill.

A gold and silver prospect along the road to Mina, about one-half mile west of Goldyke, has old workings said to consist of a caved shaft and several large open cuts. These claims also belong to Tom Burns of Goldyke.

A property owned by Walter Pfeffercorn, and others, of Mina is situated in the western part of the district, 2.7 miles northwest of Goldyke. Water for camp and mine use is hauled from Gabbs, about 8 miles north, or from Goldyke. Geologic conditions here are similar to other parts of the district; the mineralized zone is in the vicinity of rhyolite intruding the andesite. The ore is quartz containing pyrite, some of which has been altered to limonite. The principal work is a 40–50° inclined shaft having a total of about 200 feet of workings. The mine is equipped with a small headframe with homemade hoist and a combined shop and hoist house in good condition. A camp with good cabin and small outbuildings is about one-quarter mile from the shaft.

The Sullivan patented claim, owned by the Nevada Company of Reno, is in the northwest corner of the district, about 7 miles south of Gabbs. It is reported that the property has been virtually abandoned for years. The workings consist of a 60–foot inclined shaft sunk on a spotty gold occurrence with "dog holes" off the shaft made by occasional lessees. The property has no recorded production and it is doubtful that any appreciable quantity of ore has been mined here.

The Scheebar mercury mine, formerly known as the North Star, is on the northeast slope of Paradise Peak at an elevation of 8,200 feet. As the property is well described by Bailey and Phoenix, it

will be treated only briefly here. Production is estimated to be about 50 flasks, most of which was made in 1936. In 1943, J. Benjamin Parker and Julius Redelius of Reno (Scheebar Syndicate) leased the property and milled 108 tons of ore containing 16 pounds of mercury per ton at the Desert Scheelite mill east of Mina. Gravity concentration and flotation were used to make a rough concentrate containing about 35 percent mercury which was retorted in D retorts at Mr. Parker's assay laboratory in Reno. The addition of crushed coke and lime to the concentrates overcame much of the difficulty ordinarily encountered in this operation. The lack of labor at this time is reported to have necessitated the termination of mining.

FLUORINE (Beatty, Bare Mountain, Carrara, Big Dune, Lee, Telluride)

The Fluorine district as described here will be assumed to include Bare Mountain, Crater Flat with the southeast end of the Yucca Mountains, and that part of the Amargosa Desert lying southwest to the California State line. Elevations range from 2,500 feet in the desert, to 6,000 feet at the summit of Bare Mountain. The area is well served with desert roads, most of which are in fair condition. Water is extremely scarce, it being necessary to haul it to nearly all parts of the district.

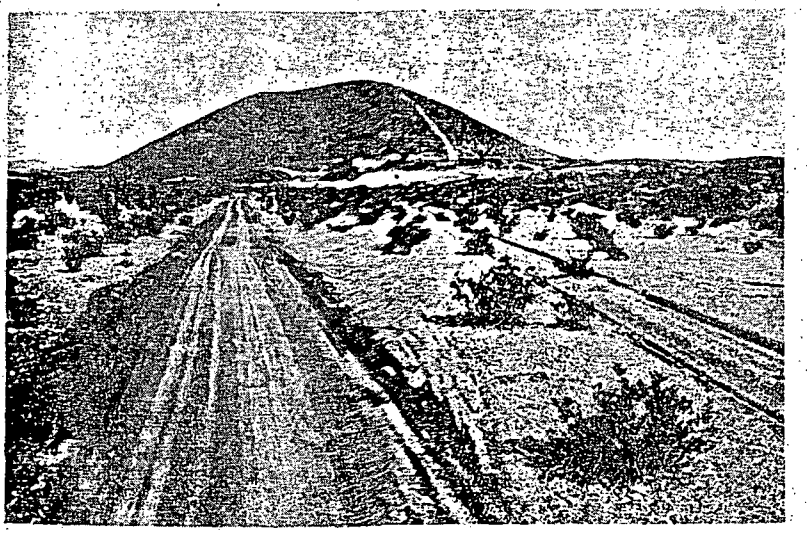
The district has produced various minerals since the discovery of gold on the east side of Bare Mountain in 1905 as described by Lincoln. Mercury was discovered in 1908 and fluorite in 1918. The most important mineral production has been from the Crowell fluorspar (term commonly applied to the ore of fluorite) mine for which Couch shows a recorded production of 31,818 tons to the end of 1949 having a value of $553,558. It is known that considerable fluorspar production in addition to this was made in the earlier years of operation. Mercury production for the district is given as 72 flasks by Bailey and Phoenix. An appreciable but unknown quantity of silica has been shipped from the district for use in the ceramic industry. Gold and silver production has been meager and none has been recorded.

Geology. Bare Mountain as described by Ball[37] is made up largely of Paleozoic sediments of which the greater thickness is Ordovician limestone with some quartzite. The sediments have a general northwest strike and dip 15-80° NE. Faulting and folding has been intense in some areas. Pegmatite and aplite dikes are common in localized sections. Ball states that the pegmatites are included in the Tertiary volcanics and are believed to be post-Jurassic. Rhyolite, andesite, and basalt Tertiary volcanics similar

[37]Ball, S. H., U. S. Geol. Survey Bull. 308, pp. 154-157, 1907.

to those found over a large area in this part of the county cover the northern hills of Bare Mountain. Rhyolite dikes are found in some areas and are associated with gold occurrences.

The volcanics in this district have a present economic importance which may become greater in the future. The general sequence is a series of rhyolite flows overlain by a rhyolitic pumiceous tuff and this in turn by a thin flow of dark dacite. The youngest volcanic rock is a basalt forming the cinder cones in Crater Flat and at the south end of the Yucca Mountains. One of the cones is now being mined for lightweight aggregate. Perlite



(8) The source of the red cinder used on southern Nye County Highways. CindRlite Company's loading bins are at the base of cone.

is found a few miles east of Beatty and lies approximately between the rhyolite flows and the tuff above. Its width was about 20 feet where observed; however, this probably varies. The pumiceous tuff is found in greater quantity and may have some future value. The best exposures of these beds are at the north end of Crater Flat, about 15 miles east of Beatty. In this locality it is estimated that an 80-foot thickness of the material is exposed and the beds were noted for 6 miles toward Beatty.

Properties. The Crowell fluorspar mine, also known as the Daisy, is 5 miles east of Beatty on the northwestern slope of Bare Mountain at an elevation of 4,500 feet. Details of the property are excellently described in U. S. Bureau of Mines Report of Investigation 3954 by Robert W. Geehan, and U. S. Geological Survey Preliminary Report 3-209 by W. R. Thurston. The data

for these publications were gathered during 1945–1946. J. Irving Crowell, Jr., whose father located the claims in 1918, has operated the property since 1927 and at the present time produces about 500 tons of metallurgical grade fluorspar per month. During 1949 and since then, the ore has been shipped direct without beneficiation. A mill installed in Beatty had been used in previous years to increase the grade of the material by washing the ore to rid it of clay.

The fluorite occurs principally as a vein type mineralization in severely faulted Paleozoic limestone. Most of the ore is soft, earthy material having a dark purple color. The principal characteristic of this fluorite is that it hardly resembles the usual mineral, the clear crystalline type being the exception. The ore bodies are very irregular in shape and distribution, probably due to post-mineral faulting as well as irregular deposition. Very little stoping has been done below the third level, therefore the ore taken from this part of the mine has come principally from exploratory workings. The size of the surface waste dump in no way indicates the amount of workings below, which total between 1 and 2 miles. Mr. Crowell suggests that the mining of the ore now being blocked out is a problem for the next generation.

The principal change at the fluorspar mine, since the above-mentioned reports were written, is the deepening of the Daisy inclined shaft from the third to the eighth level. Previously, ore below the third level was handled through winzes, finally necessitating three lifts to place in on the surface. At present all ore is handled by the surface hoist.

The mine is eletcrified wherever possible, power being supplied by a 50 kva Diesel-electric plant. All illumination is by electricity. Drilling in ore is done with three-quarter inch electric drills with coal auger bits, and a small electric slusher is used for mining. Compressed air is used only for drilling in some development workings. The surface hoist, another of the few items not electrified, is an old single-cylinder 15 horse-power Fairbanks-Morse. Because of its excellent operation at low cost it has not been replaced. As all water is trucked from Beatty the men all live in town, and a minimum of surface improvements are necessary at the mine.

The fluorspar is hauled to Beatty in 6-ton trucks which load 20-ton semitrailer units. These larger units truck the ore to the railroad at Las Vegas, 115 miles distant, making one trip per day.

The Vidano group, owned by H. C. Moore of Los Angeles, lies about 1 mile east of the Crowell fluorspar mine. Considerable

work has been done, including a 138-foot shaft and 800-foot adit said to have been driven to explore a gossan area in limestone. The principal values are in gold and silver with assay values of $6 to $14 per ton being reported. The camp has three buildings in better than average condition. Water was probably hauled from Beatty.

The old Diamond Queen mine and the Panama to the south are situated on the east side of Bare Mountain, 13 miles southeast of Beatty. Victor Ritterer of Beatty is acquainted with the properties and owns part of the claims. The first activity in the area was in about 1905, and it is reported that some production was made in 1907–1910. Some leasing has been done here during the last decade. The lack of water in the near vicinity has been a handicap; it is said that a 60-foot well in Crater Flat did not encounter water. Ordovician sediments, principally limestone and quartzite, have been intruded by one or more rhyolite dikes 10–50 feet wide striking northerly and traceable for over a mile. The gold occurs sporadically in veins or zones in the vicinity of the dikes. At the Diamond Queen, mining has been done from open cuts and a 200-foot shaft with a level at 100 feet and an adit connection at the bottom. Present ruins indicate that at one time this was a fair sized mining camp built at considerable expense.

Several attempts have been made to profitably mine the marble in the Carrara area, 10 miles southeast of Beatty. The American Carrara Marble Company started operating in 1904 but found that the marble was too fractured to obtain the large-sized, more valuable pieces. Their plant was dismantled early in 1936. Later a small company made an unsuccessful attempt to manufacture a special white cement. In more recent years the Elizalde Company planned to make Portland cement in the area and set up much equipment; however, they apparently decided to abandon the project as the equipment was dismantled before it had been completely installed. A large rotary kiln and other equipment are still at the plant. Water for this area was obtained by pipe line from the Amargosa River near Beatty. This pipe line is no longer in usable condition.

The Gold Ace mine, formerly known as the Bull Moose, is on the southwest side of Bare Mountain about 10 miles southeast of Beatty. The property is above the old marble plant at Carrara, and water was obtained from the Carrara pipe line. Gold was discovered here about 1913, and in 1915 the ground was optioned to the Tonopah-Belmont Company. They relinquished their option when the second payment came due and the property was then

comparatively inactive for several years. During this time, Charles Sutton, a former lessee, obtained title to the claims and in 1928 leased them to Boggs and Putman who installed a 75-ton mill at the mine. During 1928–1929 the camp was active but the small quantity of mill tailing does not indicate much production. Before closing, the mine was sampled by Alvin B. Carpenter, consulting mining engineer of Los Angeles. In about 1932 another company headed by a Mr. McGinnis built a 50-ton mill along the highway at Carrara. This company is reported to have done most of the work on the property and operated until April 1936 when McGinnis died. Since this time very little has been done and all improvements except two headframes and two ore bins have been removed. The production is not known as none has been recorded. The property is owned by Mrs. Chris Juhl of Beatty, the widow of Charles Sutton.

The ore at the Gold Ace occurs in bedding plane shears and veins a few inches to 4 feet wide in sediments dipping about 15° N. The many shallow workings indicate much surface concentration of gold; however, bunches of high-grade reportedly have been mined from the inclined adits and the two vertical shafts. The workings indicate a mineralized zone about 2,000 feet long, apparently in about the same bedding plane.

The Arista mine, owned by W. H. Callicott and others, adjoins the Gold Ace on the north. The present owner, who lives on the property, located the ground in 1929 and organized a company which installed a compressor and did some exploration. The company activity, however, was short lived and little work has been done since then except by Callicott himself. He reports that just before the war he shipped 1¼ tons that assayed 11.11 ounces of gold per ton. The sediments here are largely quartzite interbedded with narrow beds of talc schist having a gentle dip to the north. The ore zones are shears, often 20–30 feet wide, some of which are interbed while others strike northerly and dip nearly vertically. The workings consist of a 175-foot adit, reported by the owner to have some $40 ore of 1 to 2-foot width, a 60-foot adit on the intersection of two shear zones, and many minor diggings. Part of the compressor building and an old compressor with engine are the remaining improvements on the property.

The Grand Junction group, owned by R. B. Cothern of Beatty and others, is situated about 4 miles northeast of Carrara along one of the larger canyons in Bare Mountain. No water is available in the immediate area. The first work was done here in 1928 and since then over 1,000 feet of adits and shafts have been dug.

The principal ore is gold and silver; however, tungsten occurring as scheelite, and wolframite is also found here. Production has been small, the shipment of only one car of gold ore being reported. The rocks here are highly metamorphosed sediments, largely calcareous, which have been cut by many small aplite dikes and a few later more basic dikes. The sediments strike easterly and dip steeply to the north. The tungsten mineralization appears to have been controlled by minor structures and is rather erratic. The gold and silver occurrences are in veins and shears, the one having the major workings has a N. 25° E. strike with 60° E. dip. The ore here is found to occur in irregular shoots. Improvements consist of a camp building in good condition.

The Mexican group, owned by John Konzos of Beatty, is located 4.7 miles east of Carrara, on the southwest slope of Bare Mountain overlooking the highway. The only production is about 35 tons shipped to McGill, reported to contain $16 in gold and silver. The ore also contains lead; however, the content in the shipment is not known as McGill makes no payment for lead. The rock here is marbleized limestone interstratified with narrow talc-schist beds; the beds strike northeast and dip 20–30° SE. The ore bearing veins and shears occurring, both interbed and crossbed, are a few inches to 18 inches wide. Interbed shearing along the schist is the most prominent and has the principal ore occurrence. The workings consist of several short adits and shallow shafts. A weathered tin building in fair condition is the only surface improvement.

A group of gold claims, owned by Frank Oleniczak of Beatty, is reported to lie about 3 miles southeast of Beatty in the limestone and quartzite. Bunches of high-grade ore are reported to have been found here in 1940. The property had no production, but several hundred feet of work has been done in adits and shallow surface diggings.

The large sand dune, about 2 miles long by a mile wide and 200 feet high, situated 23 miles southwest of Beatty, is better known for the stories told about it than by its present potential value. Probably the best known tale of doubtful veracity is the report that a wagon train passing during an exceptionally heavy sandstorm lost a wagon, loaded with whiskey, that became stuck and was buried under the drifting sand. Notwithstanding the value of possible well-aged whiskey, this sand may have some future potentialities. Samples of the material show it to be of relatively uniform size, about 75 percent minus 48 mesh and to contain about 60 percent quartz, 20 percent feldspar, 5 percent calcite, 15

percent dark minerals, and 10 percent dark rock fragments. The dune is 3 miles from the highway and it was found necessary to walk the last mile as the sandy soil is not negotiable with a conventional car.

Minor beds of diatomaceous earth are found near the highway about 17 miles southeast of Beatty. One of the more prominent outcrops covers an area about 200 feet by 300 feet and appears to be 10 feet or more in thickness.

A volcanic cinder cone 1 mile north of the Las Vegas highway and 23.4 miles southeast of Beatty is being mined for road and concrete aggregate. The cone is held by location by the CindRlite Corporation of Las Vegas who ships the cinder to its building block manufacturing plant in Las Vegas. The company states that the cinders do not show a trace of sulfur. The material is also made available to the Highway Department who has built many miles of road using it as a road aggregate for which it has favorable qualities including an attractive red color. The operation was started in 1946 and apparently the cinder has been shipped from the deposit intermittently since then. Mining is done by slushing with a 1-yard scraper powered by a 66-horse-power double drum hoist. The cinders are pushed into the path of the scraper by a bulldozer. As mining and loading is rapid, intermittent mining can supply raw material for the more continuous block plant operation. Present mining is being done on a bench adjacent to the cone. It is reported that a trench 35 feet in depth dug here was still in cinders at the bottom. This would indicate approximately 500,000 yards in addition to the cone which is about one-half mile in diameter at the base and about 400 feet high.

In reference to the cinder cones in Crater Flat as well as the above-mentioned cone which is 10 miles south, Ball[38] writes an excellent description. He refers to the above cone as 4 miles east of Rose's Well. An excerpt from his writing follows:

> The cones are gently depressed and are usually superimposed upon circular basalt flows. The flows present ropy surfaces, cross fractures produced during the flow of the almost solid mass, and caverns formed by the onflow of the liquid interior after the surface had hardened into a crust, each a characteristic phenomenon of surface lavas which have been but little eroded. The

[38] Ball, S. H., U. S. Geol. Survey Bull. 308, p. 152, 1907.

cones themselves are formed in part of flows, but largely of vesicular lapilli, scoriae, and volcanic bombs. The intimate mixture of these red and black fragments imparts to the cones their magenta-red color. The cone 4 miles east of Rose's Well has on its summit a crater, 300 feet in diameter, which is depressed from 15 to 75 feet below its rim. Sulphur coats the volcanic breccia in the crater. The crater of the cone 7 miles north of Rose's Well has been largely destroyed by erosion, the throat displaying a rubble of visicular basalt fragments. The beds of fragmental material dip inward toward a common center at the crater of the cone 1½ miles farther north.

Since the eruption of the basalt the cones have been somewhat eroded, calcium carbonate has been deposited in the vesicles, shrubbery has taken root on the lava flows, and a sand dune has been superimposed upon the cone 4 miles east of Rose's Well. The basalt is probably of very late Pliocene or early Pleistocene age.

An area north of Crater Flat which was observed to extend westerly about 6 miles to within 10 miles of Beatty contains continuous beds of rhyolitic pumiceous tuff overlying rhyolite lavas. In the more eastern part of this area where the beds are better exposed the "pumicite" is found in cliffs about 80 feet high overlain by a pink tuff and dark dacite. Here the material is relatively soft and is composed of unclassified fragments of volcanic ash with particles of pumice to 1 inch in size. A large block of claims were located here in 1946 by John Konzos, William A. Martin, and Elbert Whitney of Beatty. Roads have been built into the area to make the claims accessible.

A clay deposit situated about 10 miles east of Beatty, formerly held by the Elizalde Corporation of Carrara, has been recently relocated by John Konzos and others of Beatty. The material is a hydrothermally altered rhyolite resulting in a clay of high silica content and contains narrow seams of halloysite with a trace of cinnabar.

The Silver Pearl group of perlite claims, owned by Mrs. J. W. Bruce of Fresno, California, is situated about 3 miles east of Beatty. The claims are reported to be 1 mile off the highway and have a road built to them. No known production has been made.

In recent years, pumicite has been mined near the highway just north of Beatty for the manufacture of lightweight aggregate building blocks in the Las Vegas area. However, the operation is not now active. The property is owned by Thomas L. Wells of Los Angeles, and others. Improvements consist of an ore bin and some loading equipment.

The Paramount placer property, owned by Mr. and Mrs. Chris Juhl of Beatty, is situated about 15 miles northeast of Beatty. The gravel is partly cemented and has been worked in a small way by drifting on the higher-grade material. The nearest water is said to be 5 miles northwest of the claims. No appreciable production has been made and the ground has been idle for many years.

The Silica mine, also known as the Monarch group and owned by Louis Hinds of Beatty, lies about 8 miles east of Beatty in the northwest end of the Yucca Mountains. An intermittent production of ceramic silica was made from here during the period of 1918–1929. J. Irving Crowell of Beatty probably did the last shipping in 1929. He states that silica content was 99.7 or 99.8 percent and that it carried about 0.04 percent iron. Couch shows a recorded production of $3,452 from 890 tons in 1929. The material is an amorphous silica formed by the complete alteration of rhyolite. Some of it occurs in a fine granular state. The property has been mined by an open cut reported to be 150 feet wide. An aerial tram, used to bring the silica off the mountainside to the truck road, is still on the property and reported to be in fair condition.

The Thompson mercury property, owned by the estate of G. R. Thompson, lies just south of the Silica mine. It is 12.5 miles east of Beatty via the Fluorspar mine road. Discovery of the mercury occurrence was made in 1929 by Thompson; production has been very small. As stated by Bailey and Phoenix, the cinnabar occurs as veinlets and small concentric spheres in a silicified rhyolite. Minor surface workings are scattered over a large area; however, about 1,000 feet of exploration was concentrated near the north end of the property in the hope of developing a large tonnage of profitable mercury ore.

The Harvey mercury mine is situated 8.5 miles east of Beatty on the north side of Bare Mountain. Information from Bailey and Phoenix shows the property to be owned by Mrs. Emily K. Harvey of Beatty and others. Discovery was in 1908 and 78 flasks are reported produced. During 1912–1916, ore from the mine was trucked to a Scott furnace to the north, the property

was then idle until 1930, and since then small intermittent production has been made. The ore occurs scattered in an elongated "pod" of opaline material in Paleozoic limestone. Workings consist of a main adit with short sublevels all totaling about 550 feet, and an open pit.

GOLD CRATER

The Gold Crater mining district is about 10 miles east of the summit of Stonewall Mountain and lies south of Stonewall Flat. The district is 27 miles southeast of Goldfield and its northern portion is within the Tonopah Bombing and Gunnery Range. It adjoins the Wellington district on the west. S. H. Ball[39] states that the district was discovered in May 1904 and, although many people rushed to the district that fall, few remained. Considerable work was done in the early days; however, very little production has been noted. In 1916 it is reported that 120 tons of ore shipped grossed $2,015.[40] Couch shows a recorded production of $1,208 in 1934 from 40 tons of ore. For the past several years one man has worked in the district and made intermittent shipments. His total shipments probably gross less than $5,000.

Geology. Ball states:

> The country rock, silicified and kaolinized biotite andesite, has been fractured and in many places faulted and brecciated. The intensely silicified andesite is a white or gray rock with conchoidal fracture. In some instances it is porous through the removal of the phenocrysts, and in others the casts have been filled by milky quartz. The iron-stained outcrops are very rugged, since silicification and consequently the resistance of the rock to erosion are very irregular throughout the mass.

In the vicinity of the only active property in the district the silicified andesite, which, due to alteration, looks more like a rhyolite, has been intruded by later andesite dikes. In the past, gold and silver have been the only economic values in the ore; however, the present activity is on a lead ore containing gold and silver, occurring in the volcanics as do the gold ores.

Properties. The Pius Kaelin group of patented claims, owned and operated by him, lies 2 miles west of the Gold Crater Well. Kaelin has been mining here for the past few years and has recently set up a small stamp mill with gravity concentration at Stonewall Spring, 24 miles by road west of the mine.

[39] Op. cit. U. S. Geol. Survey Bull. 308, p. 140.
[40] U. S. Geol. Survey Bull. 871, p. 68, 1936.

The ore occurs as both galena and cerussite in brecciated pipe-like zones. Milling ore contains about 10 percent lead, 14 to 24 ounces silver, and $8 to $12 in gold per ton.

The workings consist of two shallow shafts, one 20-foot incline following a pipe of lead carbonate, and a 30-foot shaft with minor laterals on a spotty occurrence of galena.

Several workings of greater extent in the district were apparently abandoned during the early days.

GOLDEN ARROW (Blakes Camp)

The Golden Arrow district is on the west flank of the Kawich Range, 16 miles south of the Tonopah-Ely highway and 40 miles southeast of Tonopah. It is not known when the Golden Arrow properties were discovered; however, Blakes Camp, 4 miles west, was discovered in June 1905.[41] The latter camp is now abandoned. Water is obtained from springs about 7 miles east, although one shaft reportedly has water at 175 feet.

Most of the work in the district was done prior to 1916 and Henry G. Ferguson [42] states that very little production had been made.

Geology. Ferguson reports andesite and rhyolite to be in fault contact along a northeast bearing zone with the andesite on the westerly side. The fault zone dips about 60° SE. and is normal. West of the fault, in the andesite, is Deadhorse Hill which is a porphyritic alaskite. In describing the area Ferguson states:

> The andesite appears to be intrusive into the alaskite porphyry of Deadhorse Hill, though the writer was not able to confirm his impression by the study of actual contacts. The irregular contact of andesite and rhyolite exposed in the workings of the Desert shaft likewise suggests intrusion, but there the relations of the two rocks are masked by the extensive slipping which has taken place. On the other hand, specimens collected on the dump of the Gold Bar shaft and said to come from the 400-foot level show a decidedly andesitic tuff in close association with the andesite * * *.

Faulting has affected all the rocks exposed in the district. The principal fault, called the Page fault on Irving's map,[43] follows the line of the hills in a general

[41] Ball, Sydney H., Notes on Ore Deposits of Southwestern Nevada and Eastern California: U. S. Geol. Survey Bull. 285, p. 66; 1905.

[42] Ferguson, H. G., The Golden Arrow, Clifford, and Ellendale Districts, Nye County, Nevada: U. S. Geol. Survey Bull. 640-F, p. 115–121, 1916.

[43] In private report referred to by Ferguson.

northeasterly direction and dips to the southeast at an average angle of about 60°. It is probably a normal fault, and the downthrow is therefore to the east. It forms the boundary between the andesite and rhyolite over the greater part of its known length. Between the Golden Arrow and Cotter[44] mines, however, east of the fault, there is a triangular area of rhyolite that is itself bounded by faults. This seems to represent a sunken block on the upthrow side of the main fault, bounded by minor faults contemporaneous with the larger one. A similar subsidiary fault separates the rhyolite and andesite on the Desert and Gold Bar claims on the Cotter property. The throw of the faults is unknown but is probably not more than a few hundred feet.

The mineralization is believed to have followed the faulting closely and to belong to the same general period. The Page fault appears to be mineralized at the Golden Arrow mine and in the prospects to the southwest, although so far as can be judged from specimens collected on the dump, the main ore body was within the rhyolite. Most of the veins in the Cotter prospects appear to branch out from the fault nearly at right angles and have not been found to continue for any great distance from it. The arrangement of the vein system here suggests that the fissures now filled by vein matter are subsidiary to the main fault. North of the Desert fault the ore is in the rhyolite, and here the fracturing is less distinct than in the andesite area. East of the Page fault ore is likewise found in the rhyolite but in less well-defined veins than where the andesite forms the country rock.

Properties. The Golden Arrow and Gold Bar groups, containing five patented claims, are owned by C. G. Hendley and others. The Gold Bar is about a mile north of the Golden Arrow or Page. Ferguson mentions the Gold Bar shaft as being a 500-foot incline accessible to 140 feet in 1916. He states:

> The ore averages about $25 a ton, chiefly in gold, but ore with an average tenor of $100 a ton can be obtained by sorting. The fineness of the gold appears to be highest close to the surface, the proportion of silver increasing with depth.

[44] Gold Bar, northeast of Golden Arrow.

Couch shows a recorded production of $4,246 from 73 tons in 1941 and 1946. Minerals Yearbook mentions lessees shipping from both groups in 1941. It is reported that shipments during recent years totaled 900 tons of $18 ore.

The Jeep group, owned by Joe Clifford of Stone Cabin, lies about 2 miles east of the old camp of Golden Arrow. Discovery of high-grade silver ore near the surface in a sheared and altered rhyolite was made as late as November 1946; since then small lots of ore have been shipped. It is estimated that a total of about 200 tons of ore of a value of $18 to $70 per ton has been shipped since the discovery. A news report[45] states the last shipment contained 28 tons of $70 ore. The ore value is about equally divided between gold and silver with the silver occasionally predominating. The workings consist of a 100-foot inclined shaft. Clifford and his sons usually work the property during the winter months when their ranching activities are not pressing.

GOLDFIELD (Quartz Mountain)

The Goldfield mining district, as here mentioned, is merely that part that has extended over from Esmeralda County. It is about 5 to 13 miles east of Goldfield. The road to the district is in fair condition; however, it is not maintained as it goes into the Tonopah Bombing and Gunnery Range. Domestic water may be obtained from small springs in the vicinity.

The areal geology is similar to much of the eastern part of the Goldfield district of Esmeralda County. Tertiary volcanics, locally altered and silicified, cover all the area noted.

Properties. The Free Gold and Extension group, owned by O. J. Brincefield and Emil Perolaz of Goldfield and Reno, respectively, lies about 13 miles east of Goldfield on a lone hill known as Quartz Mountain and is in the Tonopah Bombing and Gunnery Range. Water for camp use is obtained from a small spring 1 mile to the northwest. This Quartz Mountain should not be confused with a hill of the same name in the Lodi mining district in the northwestern part of the county.

Quartz Mountain is composed of a fine-grained dacite which has been sheared and silicified, the nearly complete silicification of some parts of the hill being the reason for its name. Gold mineralization occurred in shear zones in the dacite which are now highly oxidized.

The workings consist of an adit with about 1,800 feet of workings plus several shorter adits and shafts totalling about 500 feet of additional work. A road and ore bin have been built to the portal of the principal adit. It is understood that only minor shipments have been made from the property.

Sample results made available to the writer indicate that remnants of exposed ore average about one-half ounce gold per ton. Some of the dumps, if screened will give a minus half-inch product of approximately equal value. It appears that the ore is confined to shear zones and intersections of shears.

Any mining area as important as Goldfield stimulates much interest in the adjoining territory, therefore, in addition to the Free Gold property the district has many minor prospects, most of which have been abandoned.

[45] Tonopah Times Bonanza, Feb. 17, 1950.

HANNAPAH (Volcano, Silverzone, Bannock)

The Hannapah district lies in low hills of slight relief on the west flank of the Monitor Range, 1 to 2 miles north of the Tonopah-Ely highway. It is 18 to 22 miles by road east of Tonopah. Although water was encountered in some of the shafts at about 200 feet, no springs are in the immediate area. The nearest water is believed to be at the Rye Patch wells in Ralston Valley.

The date of discovery of the district is not known; however, J. E. Spurr[46] visited the area in the fall of 1902 and found it " * * * very young and so little developed that not much could be seen." Mr. Jack Clark of Tonopah reports that the Richardson mine was located by Ben Richardson in 1907.

Some production reportedly has been made by companies that did exploratory work in the district. In addition to this, Ben Richardson shipped ore valued at $15,900 from his mine during 1922–1935.

Geology. The low rolling hills of the district are largely rhyolite. In the mineralized areas shear zones are prominent, the rhyolite usually being brecciated. Much pyrite is often found associated with the ore minerals, particularly in the eastern section of the district. The values here are principally in silver, while in the western part of the district the ores reportedly contain more gold. The zone of oxidation is rather thin where observed, and at the Richardson mine oxidation is minor below 60 feet. Water stands here at 220 feet.

Properties. The Richardson mine, owned by Mrs. Myra Richardson and Kirk Willis of Tonopah, is near the east edge of the district. The property was operated by Ben Richardson until his

[46] Spurr, J. E., Ore Deposits of Tonopah and Neighboring Districts, Nevada: U. S. Geol. Survey Bull. 213, pp. 85–87, 1902.

death by accident in the mill. He made small shipments of ore from 1922 to 1935. Settlement sheets show $15,900 produced from 296 tons in 36 shipments. Included in this are two concentrate shipments totaling 2.9 tons.[47] Apparently little or no work has been done here in late years. Weed[48] states that the property was controlled by the World Exploration Company of Fort Worth, Texas, who did a little work in 1927–1928 but suspended operations in 1929. During the operation of the Texas company the property was known as the Hannapah Extension.

The principal workings are off a steeply inclined shaft 310 feet deep. Levels are at 60, 107, 200, and 260 feet, the lower level being under water. All drifting has been west from the shaft following a west bearing vein. Only a very minor amount of cross-cutting has been done in search of parallel veins. There has been much stoping from the 60-foot level to the surface and some between the 60- and 107-foot levels. The 107-foot level is about 100 feet long; samples[49] here averaged 2.0 feet in width and contained 0.03 ounces gold and 11.5 ounces silver.

The vein is a shear containing a small amount of quartz and an appreciable quantity of pyrite. The main ore mineral is polybasite, a silver antimony sulfide.

Although the water now stands at 220 feet, in the past it has covered the 160-foot level. The water flow is said to have increased considerably at the bottom of the shaft, however, the flow was apparently handled by a small jack type pump found installed. It is believed that dewatering of the shaft would be a minor problem.

Improvements are in generally good condition. The shaft is timbered, has good ladders, and is equipped with 2½-inch air line and 3½-inch water line. The drifts have had some sloughing under stopes but the ground stands well without timber. The headframe and ore bins are in good condition. A small mill consisting of jaw crusher, small Straub mill, and concentrating table is intact. A large sheet iron building serves as hoist house, blacksmith shop, and general shop. One small house on the property is in rehabilitable condition.

The old Hannpah mine adjoins the Richardson on the west. A group of patented claims here is owned by Earl Mayfield and

[47]Data obtained from Mrs. Myra Richardson and from private memo-report made by J. H. Wells and V. E. Kral, 1947.

[48]Weed, W. H., Vol. XVII, p. 1476, 1931.

[49]J. H. Wells-V. E. Kral private report.

James Mayzie of Tonopah. Little is known about the property except that the dumps indicate extensive workings and the shafts are partly caved. Rock on the dump contains much pyrite. Weed[50] states " * * * located in 1902 and developed by two shafts, 250 feet and 300 feet deep." He refers to some ore on the 250-foot level. It appears that nothing has been done here since the early work.

The Silver Glance Mining Company, controlled by Mark Bradshaw of Tonopah, has one patented claim lying west of the old Hannapah mine. Weed[51] states, "Property was in production prior to 1909 * * * covers gold-silver bearing quartz veins. Mine is reported to have considerable development completed and to have yielded about $300,000 (probably owner's report) during early operations."

The Silver Moon group owned by the estate of Stephen S. Clark of Tonopah lies west of the Silver Glance. The claims were located in about 1905. Jack Clark, of Tonopah, reports that two cars of ore shipped in 1912 netted $34 per ton, and a 34-foot vertical shaft on a 2-foot vein contains $12 to $15 ore.

The old Bannock mine, also known as the Volcano and located by W. H. Thomas of Tonopah as the Last Hope group, lies in the western part of the district about 5 to 6 miles west of the Richardson mine. The owner states that this property was worked in about 1912 and some ore shipped when the shaft was sunk. The principal work is a dry 265-foot 30-degree inclined shaft. The owner reports that assays vary from $2 to $20 in gold, and that one 7-foot vein assays $6 to $7, and another 5-foot vein contains 15 ounces silver per ton.

The Sam Jack group of about 14 claims lies at the extreme west end of the district overlooking the Rye Patch wells. The claims are owned by Earl Mayfield, Jack Clark, and others of Tonopah. Several shallow shafts and trenches have been dug on mineralized shear zones in rhyolite. Much of this mineralized rhyolite contains some gold with silver, and the objective has been to develop a large ore body with enough values for a high-tonnage operation. The writer[52] took samples that contained $0.10 to $2 per ton, principally in gold; however, other samples taken by reliable parties have averaged about $5 per ton.

[50]Weed, W. H., Vol. XV, p. 1221, 1922. (Information probably furnished by owners).

[51]Weed, W. H., Vol. XVIII, p. 1602, 1931.

[52]Wells, J. H. and Kral, V. E., private examination, 1947.

JACKSON (Gold Park)

The Jackson District lies on the west slope of the Shoshone Mountains and borders the Lander County line. As per Thompson and West, gold ore was first discovered here in 1864 by Thomas Barnes and the district was organized as the North Union. In 1878 it was reorganized as the Jackson. In the early days the district was also known as Barnes Park after the park-like amphitheater about 2 miles wide, near the edge of which the claims were located. The Gold Park group which includes the Arctic, Star of the West, and San Francisco patents has, as per Lincoln, a reputed but unrecorded production of $500,000 to $1,000,000. Early recorded and recently known production totals $18,000. The property became involved in litigation in 1911 and very little production has been made since then.

Preliminary reports by Bernard York (1935) on the Gold Park group and the War Eagle group are on file in the office of the State Bureau of Mines.

Geology. A Carboniferous (?) meta-andesite is the oldest rock in the area and is the host for the quartz veins in which the mineralization occurred. A Tertiary rhyolite tuff overlies the andesite in much of the district and is found in fault contact with the andesite in some of the workings. Siliceous rhyolite dikes were found intruding the andesite. Their relationship to the rhyolite tuff is not known. The ore is always quite quartzose and contains varying amounts of galena and pyrite with a little chalcopyrite in some places. The sulfide minerals are partly oxidized near the surface. Ore values are principally in gold with a varying gold-silver ratio.

Faulting has been rather severe in the district and in the Gold Park group post-mineral faulting has in some places lost the ore in addition to increasing the difficulty of exploration and development by displacement in other areas.

Properties. The Gold Park group consisting of the Star of the West, Arctic, and San Francisco patents, and several unpatented claims, is in the Gold Park basin at an elevation of about 7,500 feet. It is about 10 miles south of the State Highway Maintenance Station and the Brown Ranch on U. S. Highway 50. The Nye-Lander County line passes directly through the property, however, nearly all of the workings are on the Nye County side. Albin L. Nelson of Gabbs and Walter F. Bowler of Fallon are the owners. Discovery of the property was made in 1880 by Frank Bradley and others who sold to the Nevada Mining Company. This company erected a stamp mill which they operated but a

short time. In 1882 they recorded a production of $12,787 from 1,353 tons. In 1919 Robert S. Todd took over the property and organized the Star of the West Mining Company. He installed a 50-ton mill in 1921 which made a trial run only. In 1927 the present owners purchased the patented claims at tax sale and have made only minor shipments since then. Production prior to the present ownership is only partly recorded as considerable ore was taken from the two producing veins, namely the Arctic and the Star of the West, particularly the latter which has been worked out within the explored area. During the present ownership the Arctic has produced about $1,500 from 59 tons and the Star of the West $3,700 from 43 tons. The mineralization in these two veins is principally gold and silver with lead and some copper. All work has been done in the oxidized zone, therefore, both the sulfides and oxidized minerals of lead and copper are present. As the gold and silver content goes up with that of the base metals, the lead and copper minerals act as a guide in selective mining. The Arctic and the Star of the West are entirely separate veins about one-quarter of a mile apart and are usually referred to as different mines. Both are quartz veins in Carboniferous (?) meta-andesite.

The Star of the West vein strikes N. 30° E. and dips about 50° SE. Its width varies from a few inches to 5 feet. The vein is opened by three adits driven southwest, the upper two having 120 feet difference in elevation and the lower being 100 feet below the middle adit. The lower adit is about 900 feet long and terminates near a major fault that cuts off the vein on the northeast. The portal of the lower adit is caved. The middle adit is open throughout and has about 1,000 feet of drifting on the vein. Two intermediate levels reached from the middle adit have a total of about 700 feet of drifting. The ore appears to be cut off on the southwest by another major fault and the workings terminate here in this direction. Not enough work has been done to learn much about this fault, however, the continuation of the same or a similar vein found southwest of the fault in a stope off the upper intermediate level leads one to suspect that the vein is displaced only slightly. The upper adit is 325 feet long and has a 100-foot cross-cut. The portal of this adit is caved. As the fault cutting the northeast end of the vein is at the portal, all of the upper adit is on the vein, and it appears to be stoped to the surface for nearly its full length. The middle adit drains the workings above it and the lower adit drains the northeast part of the middle adit. The southwest workings of the middle adit are not drained as water

stands in a winze here. Director Carpenter examined the Gold Park area in 1930 and states that the values in the Star of the West vein occur near the hanging wall.

The Arctic vein strikes about N. 15° E. and dips 30–50° E. with the hillside. Its average width is about 4 feet and from information available it appears it will assay about $20 per ton in the ore shoots. The vein is developed by an inclined shaft with an adit level used to service the stoping off the shaft. Below this is another adit with about 200 feet of workings and a raise into the stopes and upper levels. The vein has been cut off by a flat fault above the lower level. It is estimated that the Arctic has about 1,000 feet of workings. The lower level is equipped with car and track.

Very little work has been done on the San Francisco vein. It is situated on a ridge above the Star of the West at an elevation of 7,900 feet. The inaccessible location of this vein, coupled with its rather low assays, make it of less interest than the others in the group. The vein strikes northerly and dips nearly vertically. It is explored by an 80-foot vertical shaft with a little crosscutting. The vein is reported to be 5 to 10 feet wide on the surface and assays about $8 per ton; however, it is reported to pinch to about 16 inches at 46 feet in the shaft. Nearby, a 90-foot inclined shaft has been sunk on a quartz vein of no apparent interest. The San Francisco workings are just over the line in Lander County.

Improvements at the Gold Park group consist of several rehabilitable buildings, and car and tracks at the Arctic.

The War Eagle mine, owned by Albin L. Nelson of Gabbs, is at an elevation of 8,500 feet and lies on the south slope of the ridge separating the Gold Park basin from Willow Creek to the south. Water is obtained from small springs about three-quarters of a mile below the mine. Nelson and others worked the property intermittently during 1934–1941 and as per his records have mined 600 tons valued at about $15,500. The mineralization is principally gold and silver. Although the lead content of the ore shipped is 5 to 15 percent, this is not included in production figures as all ore shipments were either made to the McGill copper smelter or to a custom cyanidation mill.

The gold and silver mineralization is associated with both cerussite and galena, with all the workings being in the oxidized zone. The amount of lead present indicates the relative gold and silver content and is used as a guide in selective mining. The quartz

vein is about 4 feet wide; however, only part of this is usually mined as ore. Sampling by York (1935) gave a weighted average of $23.53 per ton for an average width of 1.75 feet. The vein strikes north and dips about 45° E. It has been developed by two adits, having about 600 feet of drifting connected by a 130-foot raise. The upper adit has an 80-foot raise to the surface and an 80-foot winze. The lower adit has two 50-foot winzes and much stoping between the levels. As the topography is favorable for drift-adits, considerable depth on the vein could easily be obtained if desired. Several cuts about 600 feet north of the workings expose a vein reported to assay about $17; this may be a continuation of the main vein. Improvements consist of a house in good condition and car and rails. Very little has been done on the property in the past several years as the type of work required is too strenuous for the advanced age of the owner.

The Peterson mine is west of, and adjoins both the Gold Park and the War Eagle groups. It is at an approximate elevation of 7,500 feet and is accessible by a spur off the War Eagle road. The property is owned by Mrs. Theresa Messner of San Francisco. Known production is about 110 tons which is reported to have grossed about $3,800. The mineral occurrence is similar to that of other properties in the district; that is, gold and silver associated with partly oxidized lead minerals. The ore occurs in veins in Carboniferous(?) meta-andesite. The lower and older workings consist of a 100-foot inclined shaft and three adits having a total of about 1,000 feet of workings. The lower adit, which is open, follows a one-foot vein of moderately uniform width that has been stoped to the surface. The more recent work is on another vein discovered in 1935, east of the old workings. It is opened by a 185-foot drift-adit from which 90 tons of $26 ore is reported to have been shipped. The veins strike easterly and dip steeply to the south.

A group of claims commonly referred to as the Last Chance, owned by Steve Diemoz of Austin, lie from one-half to 1 mile southeast of the War Eagle at an elevation of about 9,000 feet. Intermittent work was done on these claims during 1933–1939. A few shipments were made and some ore treated in a small mill formerly on the property; however, no production records are available. The mineral occurrence is principally gold in quartz veins in meta-andesite. It is reported that more than 1,000 feet of work has been done on the claims in four adits and several shallow shafts.

The Grey Eagle group, commonly known as the old Bill Boyd property, lies just south of Willow Creek and about 2 miles southwest of Albin Nelson's War Eagle. The present owners, R. J. and C. B. Lofthouse and Jack Mullen, relocated the property in 1945. The ore is said to contain gold and silver with some lead occurring as veins in andesite. The workings consist of one 150-foot adit and several shallow shafts and cuts. No known production has been made from the property.

JEFFERSON CANYON (Concordia, Green Isle)

The Jefferson Canyon mining district lies in Jefferson Canyon about 6 miles northeast of Round Mountain on the west slope of the Toquima Range. The Kanrohat mine, more recently referred to as the Jefferson, is situated at an elevation of 6,700 feet. Roads in the area are generally fair to poor. Water is plentiful for any ordinary mining and milling use.

Lincoln states that the district was discovered in 1866 but did not become active until 1871 when a test lot of ore was shipped to Austin. The two principal producing mines, the original Jefferson and the Prussian, are apparently on the same vein which strikes northwest and dips steeply to the northeast. The original Jefferson, or South Prussian, is at the southeast end of the lode; the Prussian is at the northwest end. Both properties have had mills.

The property in Jefferson Canyon, now commonly referred to as the Jefferson mine, is not the original Jefferson. As mentioned by Lincoln, this property was discovered in 1873 by C. J. Kanrohat and was known as the Sierra Nevada; it has had a very meager production.

Couch shows a recorded district production of $473,295 from 6,882 tons during 1869–1890, all of which came from the two mines on the Prussian vein. Lincoln states that a reported $1,000,000 production has come from the mills, and one report[53] states that $200,000 was definitely produced by the mills during one year.

Geology. The Prussian vein is on the contact of Ordovician shaly limestone with late Tertiary rhyolite porphyry. The rhyolite is on the hanging wall or northeast side. Workings along the vein indicate that it can be traced for several thousand feet. About 1 mile south of these workings the sediments are intruded by the Cretaceous granite[54] which extends southerly into the Belmont district.

[53]Packard, George A., Jefferson Canyon, Nevada: Mining and Scientific Press, Vol. 99, p. 26, July 3, 1909.

The Jefferson or Prussian vein contains silver minerals as the principal value, although elsewhere the gold values predominate. Lincoln reports the Prussian ore minerals to be silver sulfides and sulfantimonides at the water level. It may be assumed that the oxidized ores contain silver chlorides. Narrow quartz veins in the rhyolite are reported to carry gold, and west of the contact, quartz seams in the shaly limestone also contain gold. Stibnite is found in seams in the shale one-half mile west of the Prussian vein. Director Carpenter has a high-grade sample of hessite, silver telluride, which came from the upper regions of Jefferson Canyon.

Properties. The Prussian vein workngs are on three patented lode claims. The Prussian, at the northwest end, is owned by Harold L. Clark of Boston. This end of the lode is said to have been worked from a 250-foot shaft which encountered much water. The other two patented claims, the Prussian South and Jefferson, adjoin the Prussian on the southeast; these are now owned by the county. It appears that no work has been done on the Prussian vein since the early days.

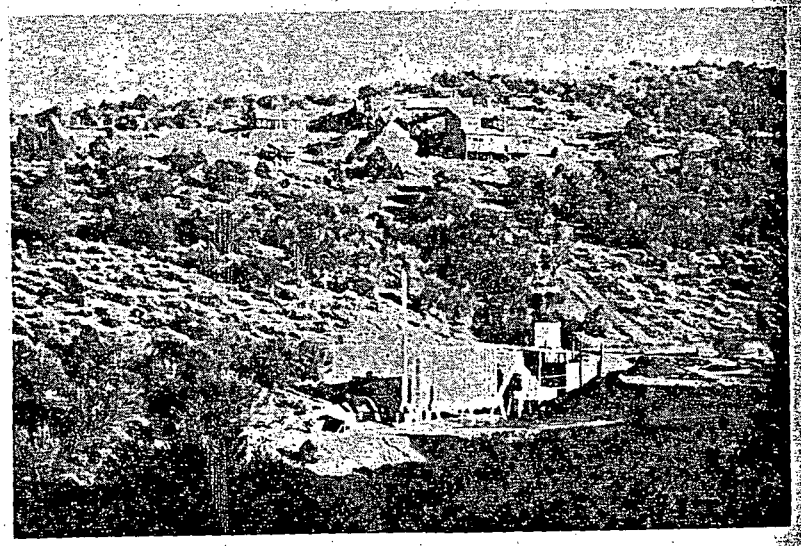
The Jefferson mine, as now designated and formerly known as the Kanrohat or Sierra Nevada mine, lies to the northeast and adjacent to the patented claims on the Prussian vein. A large group of unpatented claims here are being held by Hermann Schapals of Round Mountain, who states that about 4,000 feet of adits explore the property on four levels. In 1917 S. H. Brady took over the property for the Charles H. Stoneham interests of New York, purchased a flotation plant, and then called in Jay A. Carpenter as superintendent. Mr. Carpenter states that as the only sulfide ore he could find was in a winze from the lowest adit, he soon resigned. The mill was erected, but the low grade of the ore and the poor extraction soon resulted in failure of the project. It is said that in 1927 or 1928 the Elsa Mining Company did much work to rehabilitate the property, but they only operated the mill a few months. This was the last work done here. Improvements consist of a good mill building, housing a tube mill with classifier and several vanners, and a camp with several buildings in fair-to-good condition. The mill appears to have treated very little ore.

[54]Ferguson, H. G., The Round Mountain District, Nevada: U. S. Geol. Survey Bull. 725–I fig. 59, 1921.

The Ed Welch property, located as the Deer claim by Walter Bowler and H. W. Carden of Tonopah, lies on the south side of Jefferson Creek, 4.5 miles by road northeast of Round Mountain. Quartz stringers containing gold occur in a shaly limestone and have been explored by an adit with about 100 feet of workings. Ed Welch is said to have discovered the vein in 1932 and worked it intermittently until the time of his death in 1940. Three lessees, working the property in the spring of 1950, had installed a 3-foot Chilean type mill and were attempting to make a concentrate on Hungarian riffles.

JETT (Ledbetter Canyon, Peavine Canyon, Wall Canyon)

Although the Jett district ordinarily includes only that part of the east flank of the Toiyabe Range near Jett Creek, for the purposes of this description it will also include that minor activity found to the south as far as Peavine Creek.



(9) Mill and antimony trioxide plant at the Last Chance antimony mine near head of Wall Canyon.

Jett Creek is directly west across Big Smoky Valley from Round Mountain and is the source of water for the mining activity there. The dam on Jett Creek is 60 miles from Tonopah of which, 53 miles is paved highway; the balance is dirt road in fair condition. The elevation here is about 7,000 feet.

Thompson and West report the discovery of the district in 1865 and state that ore containing copper and silver was mined 12 miles south of the hot springs. This was then known as the Argentore or Silver Point district. In 1876, in a nearby area then known as the Toiyabe district, free milling ore containing gold and silver as well as base ore containing lead and antimony was found. Minor amounts of ore were reportedly milled at Jefferson in the early days and in later years a small intermittent production was made; however, at no time was a large production made.

Geology. In the vicinity of Jett Creek, Ferguson's map[55] shows Cambrian quartzite with interbedded limestone overlain by Ordovician limestone and this in turn by Permian sandstone and then Permian volcanics. A large fingering dike intrusive classified as Jurassic(?) porphyry bears easterly along a fault of which the north side is down faulted and mainly Permian sandstone and volcanics are exposed. The Jurassic(?) porphyry is a light colored highly siliceous rock having the general appearance of the granodiorite found to the north. The map shows the area to be severely faulted with northerly bearing faults. Thrust faults are common near the front of the range. To the south, at Wall Canyon, more Ordovician limestone and slate are shown by Ferguson and Muller.[56] These are overlain by a Permian arkosic quartzite greatly resembling an igneous rock. This rock, in turn, is overlain by Permian volcanics at higher elevations. Above these are Tertiary volcanics.

South of Wall Canyon the exposed rocks rise in the stratigraphic column. Permian quartzites are found first, then Permian volcanics, and then in the area of Peavine Creek, Tertiary volcanics prevail.

Antimony occurrences are probably of greatest importance in the district. They are found in the Wall Canyon area and south in Boyd Canyon. Lead occurs on Jett Creek and gold and silver mineralization has been prospected throughout the area.

Properties. The Valley group, owned by J. R. Mitchell of Round Mountain and W. J. Lee of Mina, is on the south side of Jett Creek adjacent to the dam which collects water for the Round Mountain district. In December 1948, a 6.5 ton shipment was made from here that contained 11.1 percent lead, 0.3 percent copper, 1.3 percent zinc, 4.1 percent arsenic, 14.7 ounces silver, and 0.08 ounces gold per ton.

A vein 2 to 3 feet wide, bearing S. 60° NW., has a drift adit of about 100-foot length with 25 feet of stoping to the surface. The

[55] Ferguson, H. G. and Muller, S. W., Structural Geology of the Hawthorne and Tonopah Quadrangles, Nevada: U. S. Geol. Survey Prof. Paper 216, plate 15, 1949.

[56] Op. cit., Prof. Paper 216, plate 1.

ore is partly oxidized and occurs with very little quartz in shales and conglomerates. This rock is part of the Permian sandstone formation. Ore found on the dump contained cerussite, galena, and pyrite. Several parallel veins in the vicinity have had minor work done on them. The ore is dropped to the canyon bottom by a vent pipe chute and about 150 tons of material is now piled at the bottom. Apparently this was considered too low grade for shipment. The property has been worked recently and has a house in good repair.

The Last Chance antimony mine is north of the ridge separating Wall Canyon from Pablo Canyon to the north. It is 6 miles by road from the mouth of Wall Canyon which is 3 miles south of Jett Creek. The property is owned by Joe Bastian of Round Mountain and others. A 50-ton mill; reportedly equipped with concentrating tables, jigs, and flotation cells; and a small shaft furnace belong to M. E. Niece of Round Mountain and others.

The stibnite occurs in massive form associated with narrow quartz stringers in a black calcareous shale within a few hundred feet of a porphyritic latite dike. In the immediate area the shale strikes east and stands nearly vertical. It appears that the ore is found to occur sporadically in shear zones.

Several groups have attempted to work the property during the last 10 years. Among them are F. A. Vollmar of Silver Peak, who mined here in about 1940, and Fred J. Delongchamps who worked the mine in 1941 and 1942. This work was done from a 120-foot shaft and a small flow of water somewhat hampered operations.

N. L. Brown did the last work on the property. In 1947 he had a 255-foot adit driven to tap the bottom of the shaft. Equipment for a 50-ton flotation mill, that had been on the ground, was then set up. Later this mill was changed to use jigs and concentrating tables. In recent years, Brown installed a small shaft furnace and condenser with which antimony trioxide was made directly from run-of-mine ore. It is believed that 100 tons or less of ore was handled in the plant, the shutdown being caused partly by a drop in the antimony market.

It appears that the possibility of economically operating the property depends largely on market conditions. It would seem that the adit driven in 1947 would reduce mining costs over those necessary during previous operations. In addition to the more operators mentioned, John Heizer of Lovelock sampled the property and has the resulting information.

The Dollar mine, owned by Herman Schapals of Round Mountain, is in Boyd Canyon about 1 mile south of Wall Canyon. The claims are about one-half mile above the mouth of the canyon. It is reported that this is an old property relocated by the present owner in 1941. The ore is said to contain antimony, copper, and silver minerals in a calcareous schist. The vein bears easterly and is about 18 inches wide. Two adits, one on each side of the canyon, with about 200 feet of raises and winzes explore the vein. No known production has been made from the property.

Peavine Creek has some minor prospects and the occurrence of fluorite is reported in the area; however, it is believed that very little work has been done here recently. Tertiary rhyolite covers nearly all the area.

The Horse Canyon mercury mine as described by Bailey and Phoenix is near the head of Horse Canyon which is a tributary of Peavine Canyon. The claims are owned by Sam Zunino and Lucile Pearce of Elko. The property had produced 46 flasks of mercury to 1943. In 1942 a 20-ton rotary furnace was installed but was sold the next year. The ore occurs in narrow sheared zones in shale and leached sandy limestone. Development includes a 325-foot adit with two raises to the surface and several more shallow workings. It is doubtful that there has been any activity here in recent years.

The Ledbetter Canyon mine or Ferir mine, as it is commonly called, is near the head of the right-hand fork of Ledbetter Canyon at an estimated elevation of 8,000 feet. It is about 5 miles east of the south end of Indian Valley on the Reese River–Cloverdale road. The group of eight claims was located in 1923 and purchased in 1927 from the original owners by A. H. Ferir, the present owner, who lives on the property. Using a Gibson mill, Ferir milled 400 tons in 1932 and in 1937 replaced the Gibson with a 14-ton Ellis mill which is now on the property. Milling water was obtained from small springs near the mine. Since 1937 very little work has been done due to the ill health and advanced age of the owner. The principal values are in gold which occurs in seams in an east-west shear zone in Tertiary rhyolite. A narrow andesite dike occurring along the shear may be responsible for the structure. The several narrow seams found in the zone are spaced close enough to indicate the possibility of a mining width of mill ore; however, very little cross cutting has been done and not enough sample data was available to indicate values. The property is explored by two drift-adits on the same structure and

a shaft connecting with the upper one. The workings total about 300 feet. The dump of the longer adit, representing about 200 feet of drifting is reported to assay between $8 and $10, principally in gold. Improvements consist of a two-room house, garage, and mill building all in good condition.

JOHNNIE

The Johnnie district lies in the extreme southeast part of the county. It includes the west slope of the northwest end of the Spring Mountains and the east slope of the Montgomery Mountains. The region is typically arid and elevations range from 3,000 to 4,000 feet. Fair desert roads make all mining properties in the area easily accessible. Water is piped to the camps from springs in the Spring Mountains. No transmitted electric power is available, but plans are on foot to bring power to the ranches in Pahrump Valley 15 miles south of the old town of Johnnie.

It is reported that the several properties in the district were discovered in 1890 by a party of men from Indian Springs. The early discovery of the Johnnie district is not surprising as the white quartz ledges outcrop prominently and may be seen for considerable distance.

The recorded production through 1913 is $382,681 from 64,582 tons. Mr. Charles H. Labbe states that the Johnnie mine itself produced over one million dollars from 120,000 tons during 1910–1913. It appears that the greatest activity in the district was during this period.

The area is well known for its gold placers. Mineral Resources (1920) states that placer gold was discovered here in 1920. W. C. Vanderburg, in the Bureau bulletin "Placer Mining in Nevada," states that in 1935 about 20 men were placering in the district. Dry placer machines were the principal method of recovery. Although the activity has dropped off considerably some placer mining is still being pursued. Vanderburg estimated that the total placer production did not exceed $20,000.

Geology. A series believed to be Prospect Mountain Quartzite (Cambrian) is the principal host for mineralization in the area. This quartzite contains beds of limestone, shale, and fine conglomerate. Some conglomerate is found in the Johnnie mine region. To the southwest, at the Congress mine, a shale underlies the quartzite which is overlain by limestone. The vein is in limestone and quartzite. The general attitude of the sediments is rather flat lying with gentle dips to the east or southeast. In the proximity of the veins the dips usually become steeper.

The ores of the district usually are in well-defined quartz veins that may be traced for long distances. Ore shoots are relatively long as evidenced by the length of near-surface open stopes. The principal ore occurrence is gold although some lead reportedly has been mined in the area.

The placer deposits of the Johnnie district would be classified as part "hillside" type and part stream placers. The deposits are always found within short distances of the source, usually less than 1 mile and often within a few hundred feet of the lode. In some instances it appears that the placer was residual, that is, the lode disintegrated and the gold was released nearly in place.

Properties. The Johnnie mine in the northeast part of the district and the Congress mine in the southern area are owned by the Congress Mining Company of San Francisco, California. Charles H. Labbe of Las Vegas was in charge of the last operations at these properties and is therefore familiar with them.

According to a report by Mr. Labbe, the Johnnie mine was discovered in 1890 and over a million dollars produced during 1910–1913. The mine consists of ten patented and several unpatented claims. It is opened by a 45° inclined 900-foot shaft and a 200-foot winze from the lowest level, with the workings estimated to total about 3 miles. Water is obtained by a 4-inch pipe line from Grapevine springs 2 miles distant. The present condition of this line will not permit more than a small flow for domestic purposes. Several buildings on the property are in good condition. Mr. Labbe states that he was on the 900-foot level in 1941 and estimated a large tonnage of mill ore above this level. The 400-foot level was examined in 1949 and ladders were in good shape to this point. The ruins of what is reported to have been an 85-ton amalgamation mill are adjacent to the shaft. Records indicate that only minor work has been done at the Johnnie mine since 1926 and nearly all of this by lessees. B. F. Couch in his Nevada production figures shows $16,274 from 1,513 tons during 1934–1940.

An attempt was being made to placer the hillside below the Johnnie mine in 1949 by Vincent and F. W. Berry and Kenneth Baldwin. The material was sluiced by high-pressure water and passed through a series of trommels and screens to concentrating tables.

The Congress mine, originally known as the Chespa, was discovered about the same time as the Johnnie mine. The property consists of six unpatented lode claims and is situated in the Montgomery Mountains near the old town of Johnnie. As per information from Mr. Labbe the mine was worked continuously from 1890 to 1895 when the lessees and owners had trouble. Two men were

reported killed, a 10-stamp mill and cookhouse burned, and the office dynamited. It appears that most of the work at this property was done by lessees. No production figures are available but several thousand tons of tailings evidence the milling. A rather new small headframe with ore bin, and hoist house with a small hoist, indicate that some work has been done here during the last 10 years. Mr. Labbe states that most of the activity was during the 1890–1895 period. The workings consist of two inclined shafts of 160 and 250-foot depths with about 1,500 feet of laterals and many surface cuts and trenches. The workings as seen from a distance outline the vein for about one-half mile. The vein strikes N. 65° E. and dips about 70° NW. It occurs in quartzite and limestone dipping 20–30° easterly with the limestone as the upper member. The ore is usually a shattered quartz and has been mined sporadically, indicating the ore to be somewhat spotty. Mr. Labbe states that the ore assays from $2 up to specimen rock and mill returns were $8 to $16 per ton. He states that the ore width was 3 to 20 feet. Water was originally piped from Horseshutem Spring 5 miles east. At present this line stops at Johnnie which is one-half mile east of the mine.

The Luck group, located by Edward and Dean Raschke of Las Vegas, lies about 4 miles west of Johnnie. The owner reports minor workings in the Cambrian sediments and an assay indicating 28 ounces silver per ton.

A lead prospect which may have had some small production in the past is situated north of the Pahrump road, about 1 mile northwest of the Johnnie mine turn-off. The property is held by relocation by Ed Kudla and Paul Gutelius of Johnnie. A bedding plane vein 6–14 inches wide in flatly lying limestone has been explored with a 350-foot drift adit and 50-foot winze. The adit exposes sporadic galena occurrences.

The gulches below the Congress mine, located by Matt Kudla of Johnnie, are the scene of the principal past placering activity. As water is scarce in the area, nearly all placering has been done by dry washers. The gulches are the main source of gravel although the side hills also have some small values. The gravel depth varies from a foot or less in some gulches to as much as 8 feet on the rolling slopes. Most of the gold is on a rough bedrock of either slate, schist, or quartzite. Vanderburg estimates that six inches of material on bedrock to run $6 to $30 per cubic yard. Observed panning of samples taken on bedrock roughly confirms this estimate; however, the quantity of this type material is not known.

Observations indicate that a better recovery could be made from the gravel by the use of one of the several small patented placer machines having a minimum water consumption. It is believed that sufficient water for a small operation of this type is available at Johnnie, one-half mile from the ground.

The Labbe mine, owned by Charles H. Labbe of Las Vegas, adjoins the Johnnie mine on the southwest and consists of four patented and three unpatented claims. Water is piped to the camp and mill from a spring to the east. Several parallel quartz veins occurring in quartzite strike easterly and dip almost vertically. They appear to average 2 to 4 feet in width and are reported to be as much as 14 feet wide in some places. The vein having the principal workings appears to be nearly 3,000 feet long. It is reported that the values are mainly in free gold and that the available milling ore will average $10 per ton. A 10-stamp amalgamation mill on the property is very well built with all steel and concrete construction and appears to be in excellent condition. A large steel water tank above the mine, mill, and camp is used as a reserve to augment the pipe line supply. Mine workings consist of several shafts, the deepest of which is 250 feet, and a few adits; there being about 2,000 feet total workings. The main shaft has a steel headframe and hoist house in good condition. No production has been recorded, but surface workings indicate much stoping. Residual type placers from some of the veins have been worked in a small way by dry methods.

The Overfield mine, formerly known as the Crown Point-Globe, is southwest of and adjoins the Johnnie mine. The property is owned by the Overfield Mining Company of Chicago. Mineral Resources of 1907 mentions the mine as having a 210-foot shaft and 1,000 feet of laterals at that time; in 1909, ore from here was treated in a one-stamp mill. Although no mention of the mine is made since 1909, considerable work has apparently been done by lessees. Several sheet-iron buildings on the property are in various stages of disrepair and a headframe with built-in ore bin at the inclined shaft is in fair condition. Some milling has been done since the early days as the ruins of an Ellis mill and a small tailing pile are still in evidence.

The Overfield vein, which strikes S. 45° W. and dips 60° SE., is very likely to be the continuation of the Johnnie vein. It is a bold white boldly outcropping quartz occurring in limestone overlain by quartzite. The bedding has a north strike with 50° E. dip. Much work has been done on several interbed veins and apparently some high-grade ore encountered. The gold readily weathers

free from the rock as the dumps show much evidence of dry placering. The property has no recorded production.

The story of the lost Breyfogle mine should probably be mentioned in connection with the Johnnie district. It has been said that men in search of the Breyfogle mine found the prominent outcroppings of the Johnnie mine. For this reason and because there is always some interest in these lost mine stories it is believed appropriate to mention the tale.

One version, and there are many, of the Breyfogle lost mine legend(?) was written by Leola McDonald.[57] She relates that Breyfogle, a six-foot Bavarian weighing 200 pounds, left southern California with two companions in the 1862 rush to Austin. The party was allegedly attacked by Indians, but Breyfogle escaped and continued north through the desert. Thirsty, and in generally poor condition by this time, he noticed a green patch on the mountainside to which he climbed. Here he found high-grade gold ore, some of which he tied in his bandana and continued on his way. His fear of the Indians, coupled with his thirst and sickened condition, drove him on without making notes or marking the spot. In due time, Breyfogle reached springs far to the north and was revived by the good water and such food as he was able to find. He then continued north toward his objective and was finally found by a cattleman in the Big Smoky Valley. Although he was in a haggard condition and his clothes were shreds, he still had the bandana of high-grade gold ore. Many attempts were later made by Breyfogle and others to find the source of the ore he brought to Austin, but to this day the outcrop has not been found.

Mr. C. C. Boak of Tonopah claims to have found evidence that Breyfogle was actually Byron W. Fogle and signed his name By. Fogle. He believes that time and its errors changed this to the present Breyfogle.

KAWICH (Gold Reed, Queen City)

The Kawich district, wholly within the Tonopah Bombing and Gunnery Range, is situated on the east side of the Kawich Range in the vicinity of the Gold Reed camp or Kawich. The range and the district were named for Chief Kawich,[58] an Indian who lived in the area.

Northeast of the Kawich district proper, in the hills between the north end of the Belted Range and the south end of the Quinn Canyon Range, are a few properties which will be described as being in the Kawich district. These claims are also in the Tonopah Bombing and Gunnery Range.

[57] Nevada State Journal, Feb. 9, 1949.

[58] Ball, Sidney H., U. S. Geol. Survey Bull. 308, p. 99, 1907.

Ball[59] aptly describes the district:

> The first locations were made in December 1904, and early in the spring of 1905 several hundred men rushed to the camp. When visited by the writer (August 1905) there were about 10 miners at work. Considerable development work has been done, two shafts reached 150 feet, and several thousand feet of drifts have been driven.

In regard to the many locations made in the early days of the district, a notice reportedly posted on the main street of Kawich read, "I claim six inches east and six inches west, O. K. Reed claims all the rest."[60] This bit of humor also has its serious side, and due to our recent assessment work moratoriums, may now reflect conditions in various districts better than it did 45 years ago.

Geology. The areal geology is briefly and well described by Ball.[61]

> The formations of the Kawich Range, in ascending order, are: Pogonip limestone, Eureka limestone, Lone Mountain limestone, granite, diorite, monzonite porphyry, earlier rhyolite with minor contemporaneous latite and dacite and basalt flows, biotite andesite, dacite, Siebert lake beds(?), later rhyolite, and later basalt and associated andesites.

In an earlier work,[62] Ball describes the general geology in the immediate vicinity of the mining activity:

> The mines are situated on a gentle sloping area of wash, from which numerous small, rugged outcrops of monzonite porphyry and smooth ones of rhyolite protrude. The monzonite-porphyry is older than the rhyolite and has so far been the ore bearer. Fresh specimens of the former are gray in color, with many large phenocrysts of feldspar and either hornblende or biotite, or both.

The ore contains free gold occurring in silicified monzonite

[59] Ball, Sidney H., Notes on Ore Deposits of Southwestern Nevada and Eastern California: U. S. Geol. Survey Bull. 285, p. 67, 1906.

[60] Byrd F. W. Sawyer, op. cit., Thesis, p. 103, 1931.

[61] Op. cit., U. S. Geol. Survey Bull. 308, p. 100.

[62] Op. cit., U. S. Geol. Survey Bull. 285, p. 67.

porphyry having iron-stained cavities and manganese dendrites. It is understood that most of the better grade ore came from near the surface. Pyrite was encountered at about 150 feet in the deeper workings.

Properties. The Gold Reed mine is the principal property in the area. Although the mine is now idle, Al and Robert Martel have reportedly shipped high-grade gold ore from here in recent years. A 300-foot vertical shaft is said to be the main working on the group. The recent shipments are said to have come from more shallow work south of the old shaft.

The Oswald claims are at the north end of the Belted Range about 5 miles east of Cedar Corrals (near Cedar Springs). The ground was located in 1938 by the present owners, Mrs. Katherine Oswald and others of Tonopah. Occurrences of argentiferous galena, smithsonite, and cinnabar are found in narrow veins and lenses in quartzite intruded by altered andesite dikes. A trial run of 1,400 pounds of selected cinnabar ore reportedly produced 14 pounds of mercury. The workings consist of a 200-foot adit, several shallow shafts and some trenching.

The Black Hawk mercury mine, owned by Mrs. Hazel Mellan of Tonopah, lies in the low hills at the south end of the Quinn Canyon Range and borders the Lincoln County line. This area is often referred to as the Queen City mining district. The claims are north of the Tonopah-Hiko road. Bailey and Phoenix in their description of the property state that 68 flasks of mercury have been produced since its discovery in 1929. The property was examined by the writer in 1941 and has had no activity since then. Cinnabar occurs in shears in what appears to be a highly altered andesite. The workings include a 45-foot inclined shaft with 160 feet of drifting from the bottom and 22-foot level. Only a small amount of stoping had been done from the drifting. It appears that most of the ore came from a few large surface cuts and trenches. The ore was retorted on the ground in two D retorts.

The Mercury group, owned by the Fallini brothers of Twin Springs, lies about 1 mile north of the Black Hawk property. Cinnabar occurs here as nuggets and as a coating of limestone and quartzite gravel found in crevices in a limestone cave. The deposit has considerable geological interest as it appears that part of the cinnabar was deposited by ascending solutions although some of the nuggets appear to have worked their way downward mechanically.

LODI (Granite, Marble, Quartz Mountain)

The Lodi district lies in the northwest part of Nye County, bordering Mineral and Churchill counties. It covers the Lodi Hills, which rise to an elevation of about 6,500 feet and are a spur off the Desatoya Range to the north. The district includes the camps of Marble with the Illinois mine, and Quartz Mountain with the San Rafael mine.

The Lodi district is often assumed to include the Mammoth district in the Paradise Range; however, as this is an entirely different mountain range and the Mammoth district is regarded as separate by mining people in that area, it will be treated here as an individual district.

The discovery of the Illinois mine in 1874 resulted in the organization of the Lodi District the following year; however, as the Mammoth district in the Paradise Range to east was organized in 1863, it is quite likely that much prospecting was done in the Lodi Hills before the area was organized. Quartz Mountain ores were found in 1920 and the camp had its boom period from then to about 1927.

Geology. Triassic limestone and lime-shale, probably dolomitic, are the principal host rocks for the ore deposits in the area. These sediments have been intruded by a granodiorite stock indicated by Muller and Ferguson[63] to be Jurassic. Nearly all contact areas have been intruded by lamprophyre dikes. The youngest rocks in the district are Tertiary lavas and minor dikes which are found principally on the northwest slope of the Lodi Hills.

Lead-silver ores with a varying gold content have by far the most economic importance in the area, with the Illinois mine and Quartz Mountain being the principal producers. Ores principally valuable for their gold content have been mined in a small way in several parts of the district, with the old camp called Granite at the southern tip of the Lodi Hills probably making the only appreciable production from gold occurring in seams and pockets. Recently, tungsten in the form of scheelite has had much attention as the Kay Cooper and Victory properties near the south end of the district have found fair grade mill ore with indications of substantial tonnages. Talc has been shipped from a deposit in the northern part of the district.

[63] Ferguson, H. G. and Muller, S. W., Structural Geology of the Hawthorne and Tonopah Quadrangles, Nevada: U. S. Geol. Survey Prof. Paper 216, Plate 1, 1949.

Properties. The old Quartz Mountain district is herein included as a part of the Lodi district. It is situated in open rolling terrain in the northwest corner of the Lodi Hills and is about 18 miles by good road, mostly oiled, north of Gabbs. Schrader[64] refers to the region as part of the Lodi Hills uplift. He states that Triassic limestones were upheaved and intruded by Cretaceous or Jurassic granodiorite porphyry and this intrusion probably was responsible for the mineralizing solutions which formed the principal lead-silver deposits. This period of ore deposition was followed by long periods of erosion, then by Tertiary volcanic flows, followed by andesite intrusions. The intrusions were accompanied by the faulting down of a large block northeast of the San Rafael mine and a second period of mineralization in the various fault shears. Subsequent erosion of the uplifted block removed nearly all the Tertiary volcanics, exposing the Tertiary ore deposits; the prospecting of these led to the discovery of the major lead-silver ore bodies in the limestone which does not outcrop.

Ore was discovered in 1920 and by the end of 1925 the Annett-Walker lease had produced a reported $90,000 from the discovery property known as the San Rafael mine. Although several mining companies came into the district at this time and did considerable exploration, only the San Rafael made any appreciable production. Couch reports the 1926–1927 production as $215,565. In 1927 the San Rafael Consolidated Mines Company acquired nearly all properties in the district and since about 1936 has produced approximately $12,000 per year from leases. L. D. Gordon of Reno is president-manager of the company. Obie Le Favor and Charles Douglas of Quartz Mountain are the present lessees.

The San Rafael is opened by a 450-foot 40° inclined shaft with about 2,000 feet of laterals. Although several veins on the property have produced, most of the production has been from the San Rafael vein sometimes known as the Lease vein. The principal ore shoot was 120 feet long, 3 to 14 feet wide, and about 280 feet deep on the dip; however, several other good-sized ore shoots have been mined. This vein is in the limestone associated with a small andesite dike and is cut off on the 352-foot level by the previously mentioned mineralized fault, sometimes known as the Vertical vein. The ore shipped by lessees averaged 12 percent lead, 12 ounces silver and 0.04 to 0.25 ounces gold. Most of the ore is oxidized, the lead occurring as the carbonate; however some galena is found as residual inclusions. Another vein occurring in the hanging wall is reported to contain milling grade ore. The San Rafael vein system is complex and is further complicated by several cross-faults. It appears that the future of the property is dependent on the development of sulfide mill ore, or finding the faulted segment of the San Rafael vein, or both.

[64]Schrader, F. C., unpublished U. S. Geol. Survey Report 17276, Carson Sink, Quartz Mountain, Sept. 15, 1927. In Nevada Bureau files.

The old Hasbrouck mine, relocated in 1946 by Obie Le Favor of Quartz Mountain and Charles Hoover of Fallon as the July group, is south of and adjacent to the San Rafael. The mine is opened by a 320-foot vertical shaft with about 1,900 feet of workings on the 220-foot level and 720 feet on the 320-foot level. It is reported to have produced two cars of good grade lead-silver ore which came from a contact between limestone and quartz-pegmatite on the 220-foot level. The shaft has a head frame and hoist, and all timber is said to be in good condition. Workings on the 220-foot level indicate the area to be all granodiorite except small blocks of limestone, shale, and quartzite which are either roof pendants or isolated islands. The 300-foot level is nearly all in granodiorite. Andesite dikes, like those in the San Rafael, are also found in the mine. Overburden covers the surface in the immediate area. H. K. and E. L. Stephenson of Reno have examined and made a report on this property.

The Desert group owned by M. C. Stromer and others of Broken Hills is situated on the northwest slope of the Lodi Hills about 3 miles by road southeast of Quartz Mountain. The property appears to have been prospected during the Quartz Mountain boom as several old workings consisting of shallow shafts and cuts were noted. An open cut 40 feet long to a 15-foot face dug by the present owners exposes a quartz vein 6–18 inches wide. The owners estimate that ore selectively mined from this vein will average about $40 per ton. The principal host rock is andesite and is usually found altered to a softer white blotchy form adjacent to the mineralization.

The Illinois mine, owned by C. I. Burt of San Francisco, consists of five patented and 18 unpatented lode claims. It is situated in the northeastern part of the Lodi Hills, 2.2 miles west of Lodi Tanks and about 12 miles north of Gabbs. The camp was once known as Marble and is so shown on the Tonopah Quadrangle of the U. S. G. S.

Discovery of the mine was made in 1875 by Alfred Welch who operated it for several years. The property has had two smelters at different times. Production has been intermittent, the recorded total being about $307,000 during 1875–1891. In late years,

lessees have made a small production from the property including stope fill and slag shipments made during the recent high metal prices. The last important activity was during 1906–1914 when, under Dr. Burt's management, a smelter was erected. Hauling between the mine and Luning was by large steam-driven, traction-wheel units. F. H. Lerchen, in a 1914 report in the Nevada Bureau of Mines files, states that water hindered work in the 1,000-foot shaft and that the last samples taken from the bottom assayed well and contained more gold. Later the Goldfield Consolidated Mines Company carried out exploratory work on the lower levels of the Illinois and sunk the 400-foot Sand Mound shaft at the southeast end of the property. No production was made from this shaft. Recently, Noel and Edwin Phillips sunk a 65-foot prospect shaft known as the Silver Link on an outcrop of lead-silver ore between the Illinois and Sand Mound shafts.

The Illinois vein system is a northwesterly bearing zone about 150 feet wide made up of the Illinois, Welch, and East veins, all occurring in limestone and lime-shale near and east of a granodiorite contact. Lamprophyre dikes of andesitic composition occur parallel and in close proximity to the ore zone. The veins may be traced for about 1 mile from the Sand Mound shaft at the southeast, to the White Pine Extension adit at the northwest. Nearly all the production has been from the Illinois and Welch veins which vary from 2 to 15 feet wide and are usually not over 20 feet apart. Only one ore shoot has been developed off the Illinois shaft; its length varies from 200 to 400 feet on the levels and extends from near the surface to the 700-foot level, the lowest level mined. The water level stands at 900 feet. The lead usually occurs as cerussite, with the silver as the chloride; however, much argentiferous galena has also been mined.

Improvements consist of the Illinois headframe and 20-ton ore bin in fair condition; the recently erected small prospect headframe and hoist; and several camp buildings, one in good condition, others poor. Noel and Edwin Phillips of Fallon are very familiar with the Illinois mine.

The Smuggler patented claim owned by John Grindling of Los Angeles adjoins the Illinois mine on the west. The property is accessible by fair dirt road to the north. About 2,000 feet of adits and shafts have been driven along a granite-lime contact shear. Some lead ore is found scattered along the mineralized contact zone and the abundance of limonite indicates the original presence of much pyrite. A sample taken from a shallow working near the west end of the property reportedly assayed 1.74 ounces gold and 7.24 ounces silver. Gold values have been found in several places along the contact shear zone. The lower adit also shows a trace of scheelite.

The Silver King and Resolution unpatented claims owned by Noel and Edwin Phillips of Fallon adjoin the Smuggler and the Illinois on the west. The claims follow a west bearing section of the same granite-limestone contact found on the Smuggler patent. The mineralized sheared contact zone forms the backbone of a steep sided ridge and contains a quartz vein having sporadic occurrences of galena and cerussite traceable for a claim length or more along the ridge. An old shallow shaft, now inaccessible, is the principal work done on the outcrop. About 250 feet vertically below the ridge on the north side a cross-cut adit encountered the vein at about 300 feet and has 50 feet of drifting to the west. The vein here is 2 to 3 feet wide and three samples taken by the owners reportedly averaged 16 percent lead, 28 percent zinc, 12 ounces silver, and 0.02 to 0.45 ounces gold. The claims are accessible by a steep road to within about 600 feet of the adit, and construction of the balance of the road will not be difficult.

A talc property a few miles north of the Illinois mine, located in 1945 by W. D. Edds of Mina, is now owned by Wright H. Huntley and G. Crawford of Bishop. It is reported that the deposit is mined from an open cut and that about six carloads were trucked to a grinding plant at Laws, California, in 1949.

The Aspen group, owned by Vet S. Baxter of Fallon, is situated just west of the west side of the Burnt Cabin summit on the Quartz Mountain Ione road. The property is reported to have been discovered in the early 1900's and was later worked by Silvereno Penelas. No production is recorded although small lots of ore reportedly have been shipped. The values are in gold occurring sporadically in a white quartz with manganese in a highly altered tertiary rhyolite. A 40-foot inclined shaft is said to have produced 100 tons of $19 gold ore before the ore was bottomed or faulted. The sinking, nearby, of a 100-foot vertical shaft with 400 feet of laterals has failed to pick up the ore. This shaft is timbered and equipped with a headframe, all in good condition. Improvements include a cabin in fair condition.

The Victory tungsten claims, situated near the south end of the Lodi Hills, are 10.5 miles by road from Gabbs. The group was located in 1945 by W. L. Sovy and Jack Southerland of Fallon, and Albert Brown of Gabbs. Since the locations the owners concentrated their efforts principally on surface exploration by

trenching, which at least partly outlined the main ore body occurring as a scheelite dissemination in the granodiorite stock forming the south end of the Lodi Hills. Their trenching indicates mill grade ore over 100 feet long and as much as 36 feet wide. A 112-foot adit driven to cross-cut this body has not yet reached its objective. Of lesser importance are contact metamorphic deposits found for about 2,000 feet along the northerly bearing limestone-granodiorite contact on the west side of the property. For the most part, the ore along the contact is too bunchy to be of importance; however, about 12 tons of high-grade ore taken from short adits at one occurrence is reported to assay 19 percent WO_3.

The Kay Cooper group of tungsten claims adjoining the Victory on the east is owned by Carl H. Cooper and R. C. Peterson of Gabbs. These claims are on a scheelite mineralization similar to the Victory and were located in recent years after the Victory discovery. Although part of the granodiorite-lime contact is on the property, the ore here is similar to that on the adjoining claims, and occurs principally in the granitic rock. Exploration by the owners was largely trenching.

The Kay Cooper group, and later the Victory group, were taken over in 1949 by J. S. Dougan and associates of Salt Lake City. This organization did much trenching on the Kay Cooper group in the fall of 1949 and did about 3,000 feet of diamond drilling on both properties in the spring of 1950. It is reported that the exploration found wide widths of scheelite ore.

The Kramer-Osgood property, owned by E. P. Osgood of Reno and others, is east across a wide wash from the Kay Cooper tungsten claims. The ground was apparently last worked by G. L. McIntyre of Carson City who leased the property in 1939. He shipped 4 tons reportedly having a value of $59 per ton. Osgood reports that 33 tons shipped in 1933–1934 assayed 0.25 ounces gold, 60 ounces silver, 7.1 percent copper, and 3 percent lead. The vein is usually only 3 to 8 inches wide although in some cases it has opened out to wider widths. Two drift adits, each about 300 feet long, have been driven, one above the other, in a basic dike occurring in granodiorite. Ore has been found in the lower adit only. In addition to the adits, there is a 30-foot shaft on the property exploring a parallel vein and the owner reports other parallel veins with little or no work done on them.

The Ray Ricketts group, owned by Bill Gregory of Weimar, California, is a gold property at the extreme south point of the Lodi Hills, about 6 miles north of Gabbs. It is reported that Ricketts mined some high-grade ore from here years ago. The ore occurred in pockets in the granodiorite, and the many shallow workings on the property are the result of following the narrow gold bearing stringers.

The Aunt Ethel lead-silver prospect is situated about 10 miles north of Gabbs on the west slope of the Lodi Hills. It was originally located as the Iron Mountain group and in 1934 relocated in seven claims by the present owner, Charles Douglas of Quartz Mountain. The ore occurs in small seams containing limonite, cerussite, and galena in steeply tilted calcareous sediments cut by porphyritic rhyolite dikes. Sorted ore is reported to assay a trace of gold, 12 ounces silver, and 27 percent lead. Workings consist of three shafts, each about 65 feet deep; a short adit; and several open cuts. No production has been made as the property is strictly a prospect. A report on this property by Fred Humphrey is on file in the Bureau office.

LONGSTREET (Fresno, Georges Canyon, Mine Canyon)

The name Longstreet has been applied to that part of the east side of the southern end of the Monitor Range near Longstreet Canyon. However, as this particular area and its name are well known, for the purposes of this description it is enlarged to include two other areas in the southern part of the Monitor Range. These are Georges Canyon, locally known as the Fresno district, on the east side of the range, about 18 miles by road north of the Tonopah-Ely highway; and the Mine Canyon area on the west side of the range, about 12 miles air line south of Belmont.

The section known as the Fresno district may be the oldest of the group, having been located by Charles Ira Fancher in about 1903. Just how the area happened to have been given the name Fresno is not known. It is reported that about $12,000 was recovered from the Clipper mine in the early days. The Longstreet mine reportedly milled ore valued at $10,000 during 1930. The total production from the district is therefore believed to be less than $25,000.

Geology. Tertiary volcanics make up the bulk of the rocks in the district. They grade from rhyolites near the bottom, to dacites and latites near the top. On the east side of the range, between Georges Canyon and Longstreet Canyon, are prominent cliffs clearly showing the various volcanic flows. The volcanics are much thicker in this area than in the northwest part of the district near Mine Canyon. Here the erosion surface was down to the sedimentaries when the latite was released. The bottom of the lava, with quarzite below and various fragments and boulders

of the quartzite included in the lower part of the lava, may be clearly seen in a wash southwest of the mine. This wash now has approximately the same slope as the original erosion surface. In the vicinity of the Last Chance mine a thin remnant of limestone overlies the quartzite. On the ridges of this area most of the latite has been eroded.

Properties. The Clipper mine, discovered by Charles Ira Fancher in about 1903, lies in a side canyon just off Georges Canyon. The property is now owned by the heirs of the discoverer, Louise May Rawlings of Fresno, California, and Ira D. Fancher of Reno. The claims are 18 miles by desert road, the upper part of which is in poor condition, north of a point on the Tonopah-Ely highway 30 miles east of Tonopah. Water may be obtained from the workings and from a spring on the ground.

Although the discoverer worked on the property intermittently until the time of his death in 1943, the major activity was probably in those years just before and just after World War I. Mineral Resources (1929) mentions lessees making some shipments from the property in 1929. It is reported that a total of about $12,000 was recovered from all shipments made. At one time the property reportedly had a two-stamp mill.

The workings consist of a 180-foot shaft, now partly caved, with minor amounts of workings on several levels and a 400-foot adit connecting with the shaft. A 30-foot winze from the adit level was abandoned when it encountered water.

Old notes in possession of the owners mention narrow high-grade seams in the upper levels of the shaft. Ore milled from the 150-foot level is reported to have assayed $317, and ore shipped from the adit level is noted as having assayed $38 to $64. The values in the ore are said to be half in gold and half in silver.

The Little Joe claim owned by Joe Clifford is in the Georges Canyon area. The owner reports that 5 feet of ore in rhyolite assays $14 to $20 in gold with little silver. The ore is opened by an 87-foot steeply inclined shaft. The workings are 1,500 feet from the nearest road.

The Longstreet mine is 25 miles north, by fair dirt road, of a point on the Tonopah-Ely highway 30 miles east of Tonopah. The mine is in Longstreet Canyon 2 miles above its mouth. The property is named for Jack Longstreet, a notorious character of the earlier days of southern Nevada and the Tonopah region. Longstreet[65] is best remembered by the missing upper part of his right

[65]Tonopah Times Bonanza, 50th Anniversary Number, May 19, 1950.

ear. This marking was reportedly bestowed upon him at the age of 16 by a Colorado posse who hanged his four confederates when they were found with several stolen horses. Due to his age he was merely marked and persuaded to leave the country.

The mine is owned by the Golden Lion Mining Company and under lease to John N. Richardson of Alameda, California. A 100-ton cyanide mill was built on the property by the present owners in 1929 and Mineral Resources reports 1,000 tons of $10 ore being milled in 1930. The mill has since been removed.

The ore contains values in gold and silver associated with pyrite and very little quartz. It is found in a rhyolitic tuff with reported porphyritic dikes. The vein is said to average $10 per ton across a 4½-foot width.

Mr. Richardson reports that the property has 2,550 feet of workings, all open, of which 1,600 feet is in ore. This work is in two adits and a shaft, all connected. The ground has been sampled several times and it may be assumed that the owner or lessee have considerable information on the value of the ore. Improvements have all been removed except 2 miles of pipe which is said to supply water to the mill site.

The Longstreet Placers, situated at the mouth of Longstreet Canyon, are owned by James Shea and others of Las Vegas. It is reported that the surface detritus pans a little and that three nuggets were found in the canyon years ago. Exploration is said to consist of a few shallow shafts, but none have gone to bedrock.

The Last Chance group, owned by Guy I. Burch of Tonopah, is on a small ridge near Mine Canyon on the west flank of the Monitor Range. It is 33 miles from Tonopah and of this distance, 19 miles is oiled highway, 4 miles improved Belmont road, and 10 miles desert road partly improved. A well, 30 feet to water, has been sunk in a wash about 1,000 feet from the workings.

The property dates back at least to the early twenties. It was obtained from Mickey Sullivan by Herman Reischke in about 1925 and sold by Mrs. Reischke to the present owner in 1934. It is reported that about 15 tons of ore averaging 21 ounces silver, 21 percent lead, and 2 percent zinc per ton, were shipped in the late twenties. Lessees shipped 20 tons of ore containing 7–8 ounces silver and 8 percent lead per ton in 1938.

The geology of the property is complex due to considerable faulting. It appears, however, that in the immediate vicinity of the workings a flatly lying limestone overlies a quartzite and is in turn overlain by a latite flow. Northwesterly bearing faults,

with the northeast side downfaulted, have in some places made a quartzite-limestone fault contact and a few hundred feet east a limestone-latite fault contact. This faulting has made a northwesterly bearing shear zone which was further disturbed by cross faults. These areas appear to be favorable to the ore deposition which usually occurs in irregular pipes and chimneys. The ore is extremely quartzose. Lead and silver, occurring as argentiferous galena with a nearly negligible gold content, are the valuable constituents.

A trial shipment of one ton assayed 0.025 ounces gold, 20.3 ounces silver, 21.1 percent lead, 3 percent zinc, 14 percent iron, 16 percent sulfur, and 38 percent insoluble. This would indicate an appreciable quantity of pyrite with the galena. An engineer's sample of ore taken near the surface assayed 0.025 ounces gold, 50.6 ounces silver, 35.3 percent lead, 0.5 percent zinc, and 6.1 percent sulfur. Two dump samples averaged 0.025 ounces gold, 4.6 ounces silver, and 4.1 percent lead.

The workings consist of a 100-foot timbered two-compartment vertical shaft in good condition but without headframe, a 200-foot adit, and several shallow shafts and holes. The property is well equipped and improved. In fact, nearly everything required in order to go to work is on the ground. Bins, crusher, elevator, and homemade jig have been neatly set up with an apparent plan toward making a rough concentrate; however, it appears that the concentrator was never quite completed and has not operated.

MAMMOTH (Brucite, Gabbs, Ellsworth, Marble Falls, Paradise Range)

The Mammoth district is in the northwestern part of Nye County and is that part of the Paradise Range lying between the Bruner district on the north and the Fairplay district on the south. It is made up of several smaller areas, sometimes referred to as mining districts; these are Marble Falls, Ellsworth, Downeyville, and Gabbs. Activity in recent years, at the Gabbs magnesite and brucite deposits, has made this one of the important areas of the State.

As per Thompson and West the first ore discovery was made at Ellsworth in 1863 by Indians and the district was organized the next year. In 1870 a 10-stamp mill was built and the community of Ellsworth had a population of about 200; however, during 1874–1881 the mill operated only part time and the population dropped to 20; at present no one lives in the Ellsworth area. In about 1915, Donald C. Cameron and others reworked the tailings here and the region had intermittent activity until during World War II when the magnesite and brucite deposits boomed the Gabbs area.

Brucite was discovered near the present town of Gabbs by Harry Springer in December 1927 and later the analyses of diamond drill cores revealed the presence of magnesite in vast tonnage adjacent to the brucite bodies. During World War II the Gabbs magnesite deposits were the sole source of ore for the world's largest magnesium reduction plant, operated near Las Vegas, Nevada. As per Callaghan and Vitaliano[66], 81,272 tons of magnesium metal was produced from 920,000 tons of ore from September 1942 to November 1944 when the plant was shut down. By the end of 1949 about 225,000 tons of magnesite and 444,000 tons of brucite had been mined for use principally in the refractories industry.

Geology. Triassic sediments[67] are the host rocks for the ore deposits at Downeyville and Gabbs in the southern part of the district, and the underlying Triassic(?) meta-volcanics are the principal host rocks for the deposits in the northern part of the district. In the Gabbs area the sediments have been intruded by a granodiorite stock indicated to be Jurrasic by Callaghan[68] (1933). Numerous dikes are also found associated with the ore deposits in this area.

The economic minerals are various in the Mammoth district. Although the magnesite and brucite are of the greatest importance today, the gold and silver ores of the Ellsworth area were the first attraction and continued to be of economic value for many years. Lead-silver ores are found along the west slope of the Paradise Range with the Downeyville ore also containing appreciable zinc. Gypsum is found near Downeyville; also, there are several small copper prospects to the northeast. Pyrophyllite is found between Downeyville and Ellsworth, and east of Gabbs; the latter area also has an iron deposit.[69] Tungsten occurs as the mineral scheelite near Gabbs and as wolframite near Ellsworth.

---

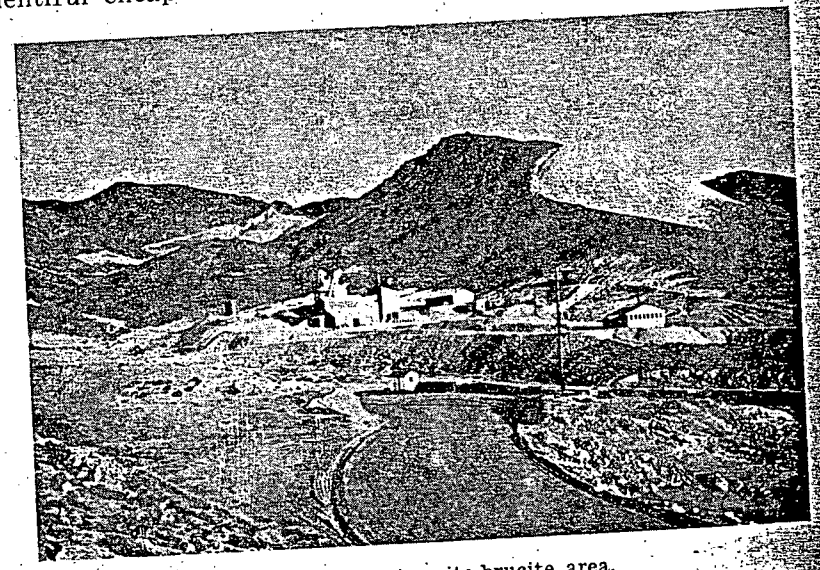
[66] Callaghan, Eugene and Vitaliano, Charles J., Magnesite and Brucite Deposits at Gabbs, unpublished, in files of Nevada State Bureau of Mines, 1947.

[67] Spurr, J. E., Nevada South of the 40th Parallel: U. S. Geol. Survey Bull. 208, pp. 99–103, 1903.

[68] Callaghan, Eugene, Brucite Deposit, Paradise Range: Nev. State Bur. of Mines, Vol. XXVII, No. 1, p. 11, 1933.

[69] Kral, Victor E., Phelps Stokes Iron Deposit, U. S. Bureau of Mines R. I. 4200, 1947.

Brucite and Magnesite Properties. Basic Magnesium, Incorporated, government-owned and privately operated, was organized for the sole purpose of making metallic magnesium for war use. Basic Refractories, Incorporated, of Cleveland, Ohio, and Magnesium Elektron, Limited, an English concern, established BMI early in 1941. By November of the same year, with 100 percent government financing, the erection of the processing plant was started at Henderson, near Las Vegas, at the source of plentiful cheap electric power. In 1942 the operation of BMI



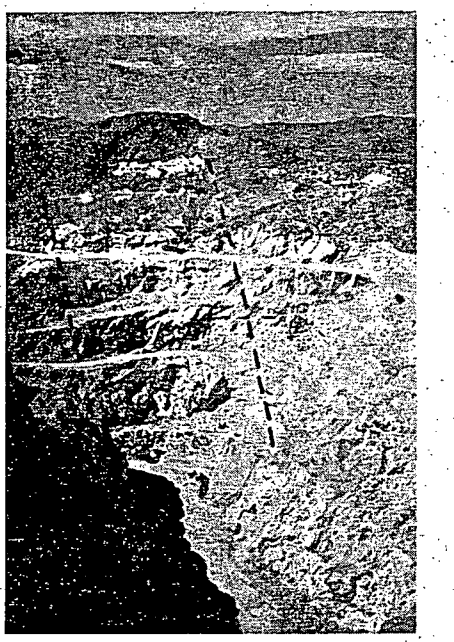
(10) Gabbs magnesite-brucite area.
Upper. Recently constructed plant of the Standard Slag Company. The upper right part of the photograph shows one of the large dumps of Basic Refractories' brucite mining. In the left distance are open cuts of the Sierra Magnesite Company's magnesite mining.

was turned over to the Anaconda Copper Mining Company, who operated the venture until the end of 1944 when the emergency need for additional metallic magnesium had ceased to exist.

The construction and operation of the BMI plants is considered to be one of the major engineering feats of the last war. Although the process is the same as one used in an English plant built by German engineers, the BMI plant was many times larger and was built in record time. The formal agreements between the government and BMI were signed in August 1941. The first regular shipments of magnesium oxide from Gabbs were made just a year later. Shortly afterward, the first magnesium metal

was poured at Henderson. The cost of producing metallic magnesium was greatly lowered by processing changes made by the Anaconda technical staff.

The Gabbs plant was known as the Magnesium Oxide Plant. Here the nearly pure magnesite ore was concentrated by flotation. The technique was unusual in that the amount of concentrate was greater than the tails. The concentrate was dried and calcined to convert the magnesium carbonate to magnesium oxide by driving off carbon dioxide, and shipped to Henderson for processing. Originally, the Gabbs product was trucked to Luning and shipped 1,100 miles by rail. Later it was trucked by special large hopper-bodied trucks direct to the processing plant, 350 miles distant.



(10a) Gabbs magnesite-brucite area. North face of Basic Refractories' "upper quarry." Brucite ore in this face is approximately outlined by the dashed lines. Granodiorite is on the left and altered dolomite is on the right.

Brucite is a magnesium hydroxide mineral having a theoretical 69 percent magnesium oxide content. Since 1937, Basic Refractories, Incorporated, and its predecessor Basic Ores, Incorporated, have made regular shipments to its refractories processing plant in Ohio. This company has a long-term agreement with U. S. Brucite Corporation, the owner of nearly all known brucite reserves in the district. Basic Refractories also has taken over all claims located by BMI; these claims were located for magnesite reserves. As per Couch (1949), to January 1949, Basic Refractories mined and shipped about 444,000 tons of brucite ore, averaging 60 percent MgO, from the Gabbs deposit which they used in the refractories industry; it is estimated that 43,000 tons was shipped in 1948. Brucite is now produced by handsorting reserve dumps accumulated from previous quarrying operations. Sorting is done on a belt installed at the BMI plant, which was taken over in 1949.

Basic Refractories has just installed a large rotary kiln which they soon plan to use in the manufacture of high magnesia refractories from magnesite ore which will be quarried on claims formerly owned by BMI. It is estimated that about 200,000 tons of magnesite will be mined annually.

The home office of Basic Refractories, Incorporated, is in Ohio where they make magnesia refractories used principally in basic open-hearth steel furnaces. H. C. Lee is vice-president and technical director of the company; at the Gabbs operation, N. E. Hanson and H. P. Willard are manager and assistant manager, respectively, of the company's Western Division.

Sierra Magnesite Company, an equally owned subsidiary of Permanente Company and Westvaco Chlorine Products Company, has produced 225,000 tons of magnesite since 1941. The material has been used in the manufacture of refractories and oxychloride cement. All production has come from one area included in a claim leased from Standard Slag Company and two claims leased from Nevada Massachusetts Company. From 1941 to 1946 the magnesite was quarried, since then all production has been from underground mining on Nevada Massachusetts property. Output during 1949 was about 50 tons per day which was recovered by shrinkage stope methods and transported from underground by conveyor belt. Production during 1950 has been on a limited basis. H. J. Tillia is in charge of the Nevada operation.

The Standard Slag Company owns five claims in the Gabbs area; and their operation here is supervised by R. O. Jones. Early in 1949 the company installed a crusher and bins at one of the magnesite quarries mined during World War II by BMI and opened a new quarry on another ore body that previously had been blocked out by drilling. During April and May of 1949 they filled a contract for 11,000 tons of high-grade magnesite that was shipped to Japan. Since the shipment of this ore, all efforts have been concentrated on the construction of a small magnesite calcining plant.

The plant has been in operation since the early part of 1950 and is making a pure caustic magnesia which is sold to cement manufacturers and to the chemical industry. The calcining part of the plant is built and operated on an experimental pilot plant basis, while the crushing section was installed with a plan to future handling of about 100 tons magnesite per day. It is planned that the calcining portion of the plant will be enlarged

gradually and ultimately will produce magnesia for refractory uses. The company recently built a pilot plant in the Pittsburg, California area for the production of pigment ingredients composed of iron and magnesium salts. This plant ties in with the activities at Gabbs.

As stated by Callaghan and Vitaliano, the Gabbs brucite and magnesite deposits occur in Upper Triassic dolomite near a granodiorite intrusion. The brucite is usually on the contact while the magnesite is often some distance from the granodiorite. It is presumed that the dolomite altered to magnesite and part in turn to brucite. This sequence is very general as the alteration and replacement of one mineral by another in the deposits is complicated by many steps and several alteration minerals not here mentioned.

Measured ore reserves, as stated by Callaghan and Vitaliano,[70] are 27,000,000 tons of magnesite containing less than 5 percent CaO. Brucite reserves are not known; however, the deposits are smaller than the magnesite bodies and go to depths not yet determined, therefore requiring closely centered drilling to deeper depths, as is being done. Brucite may later be mined by underground methods, but preparation for this has not as yet been undertaken.

Director Carpenter, who has been in close contact with these brucite and magnesium properties from the month of discovery, relates the following human-interest incidents:

Harry Springer, while working on his tungsten property beyond Albert Brown's "zinc" showing, noticed a peculiar bony weathering in the bedded "limestone." He sent a sample to the Southern Pacific geologist who found it to be the unusual mineral brucite.

The deposit was later drilled by the Standard Slag Company under option from the U. S. Brucite corporation and only then was the surrounding unusual type of bedded magnesite recognized, and this through the surprising analyses of the cores.

In 1933, the U. S. Geological Survey estimated the tonnage of magnesite up in the millions of tons but, like the competing magnesite companies, could see no commercial value in such a desert deposit so far from market. In about a decade it was supplying the world's largest metal magnesium plant!

During the depression years the Standard Slag Company gave up its brucite option but returned later to purchase "Mayor"

[70] Op. cit. Magnesite and Brucite, unpublished.

Brown's "zinc" claims containing the largest tonnage of the purest magnesite in the district.

The Basic Refractories Company leased the brucite claims and located many magnesite claims. Henry J. Kaiser and the Westvaco Company, as users of magnesite, secured the "tungsten" claims, as the tunneling and diamond drilling in previous years had actually proven up an unsuspected large deposit of high-grade magnesite.

The location of the brucite deposit by lode claims instead of placer was challenged in court, but the challenger's placer lode descriptions were suddenly found not to cover the brucite!

Other Properties. The Phelps Stokes iron deposit, also known as the Iron Mountain claim, is situated in the Paradise Range northeast of the Gabbs magnesite-brucite deposits and 7.7 miles east of Gabbs by road. The one claim was patented in 1907 and is now owned by J. G. Phelps Stokes of New York. In 1944 the U. S. Bureau of Mines explored the deposit by diamond drilling and trenching. The report by Kral[71] indicates an irregular magnetite deposit 800 feet long by 30 to 200 feet wide having a maximum depth of 160 feet. The deposit is a replacement in dolomite along a granodiorite contact. Analyses indicate the ore contains 45-50 percent iron and about 0.06 percent phosphorous. The sulfur content of most of the drill hole samples, below 50–70 feet, averages between 3 and 5 percent; however, the surface ore, within 50–70 feet of the surface, is thoroughly oxidized and contains very little sulfur. Although no production has been made from the property, it is expected that a small tonnage of the ore will be used in the future manufacture of refractories at Gabbs.

The Standard Slag Company has the Phelps Stokes iron deposit under lease and recently did some surface exploration. They dug several pits and trenches which were sampled with jackhammer holes. Their results indicate a considerable tonnage of ore near the surface containing 58 percent iron with a low sulfur content.

The Copper Blossom group located by Vet Baxter of Fallon and discovered by him in 1912, is situated 4 air line miles east of Gabbs. A poor "Jeep" road comes within about 1 mile of the property. Minor surface excavations have been made on oxidized copper occurrences in dolomitic limestone. A shipment of 10 tons made in 1915 assayed 15 percent copper, 1 ounce silver and no gold.

Downeyville is one of the old lead mines in the State that once

[71]Op. cit. R. I. 4000.

could boast of a smelter. The old workings are on the west slope of the Paradise Range, 2.8 miles northeast of Gabbs; they may be recognized by large red and brown dumps of gossan. The property is owned by the Nevada Company of which J. G. Phelps Stokes of New York is president and John M. Hiskey of Reno is general manager.

The rocks in the vicinity are blue limestone with frequent narrow beds of a light gray limestone, this series being overlain by the gray limestone which forms the tops of the nearby peaks to the northeast. The ore apparently was deposited in areas of cross fracturing in the limestones and therefore occurs as pipes or chimneys. Usually these bodies vary in width from 2 to 6 feet and in at least one of the workings they were long enough or frequent enough to allow the stopes to connect with the bottom of the main vertical shaft which has an approximate depth of 380 feet. Most of the ore mined has been oxidized and is a very porous gossan containing cerussite and wulfenite; however, sulfide ores were encountered in the deeper workings. A few tons of sulfide ore piled on the shaft dump contains a high percentage of pyrrhotite with marmatite and galena.

Mining has been restricted to an area about 1,000 feet by 500 feet containing numerous shallow shafts and "grass root" stopes. The principal work was done in the previously mentioned shaft and its adjoining stopes. Shaft timbers appear to be in fair condition, but ladders are not complete; however, it is possible to enter the lower levels through the old stopes. No headframe or other surface improvement is left on the property. Production records show 2,357 tons mined in 1875–1887 giving a gross yield of $80,622, but since that time the only production has been recently when the price of lead made it possible to ship all the slag dumps and some of the oxidized ore dumps to the smelters.

A low-grade tremolite deposit of reported wide width, recently located by E. H. Berryman of Gabbs and Frank M. Miller of Fallon, is said to lie east of Downeyville.

A lead-silver property, formerly known as the Lime Dyke claims, lies on the west slope of the Paradise Range, on the north side of Germany Canyon, and about 8 miles north of Gabbs. The present ownership of the claims is not known.

As per a report by Fred Humphrey (1945), on file in the Bureau office, the ore occurs as a mineralized fissure in dolomite with replacement widths usually varying from 2 to 12 inches. A 53-ton shipment made in 1945 assayed 0.53 ounces gold, 11.0 ounces silver, 10.6 percent lead, and 2.2 percent zinc. The workings

consist of a 100-foot drift-adit connecting with a 60-foot shaft. A small building in fair condition on the property may be seen from Lodi Valley and serves as a means of identity.

The Germany and Japan patented claims, owned by C. I. Burt of San Francisco, are in Germany Canyon south of and below the Lime Dyke claims. A long adit with winze, driven from the floor of the canyon on the Germany claim, is reported to show galena associated with other sulfides.

The Last Chance group of three patented claims, owned by John Poeter of Gabbs, lies on the west side of the Paradise Range north of Germany Canyon at an elevation of about 7,200 feet. The ground has not been worked since the early days and many of the old openings are caved. Couch shows a recorded production of $5,461 from 166 tons in 1876–1877. Poeter is now installing a tram on the 30° slope between the workings and the road above. The tram is novel in that it consists of a gasoline engine locomotive running on rail-like guides and motivated by reeling in or out a wire rope anchored at the top. It is reported that the workings have been extensively stoped, about 300 feet of stoping being in evidence on the surface. The ore is said to occur in limestone and lime-shale. A 190-foot shaft and another of 50-foot depth are open but not readily accessible.

The Big Springs mine, of unknown ownership, is situated two miles north of the old camp of Ellsworth on the road to the Penelas mine. A small spring lies about one-half mile north of the property, and it is reported that at one time a 2-stamp mill was built below the spring to treat small lots of ore from the area. Narrow quartz veins occur in meta-volcanics near a granitic intrusive. One glassy vein exposed in a caved shaft is about 6 inches wide; it bears N. 40° E. and dips 60° SE. The rather shallow workings are caved and it appears that no work has been done for many years. A report of examination of this property by Bernard York in 1935 is on file in the Bureau office. York sampled a cross vein to the one mentioned above and found it to have a width of 10–18 inches. Although most of his samples were quite low, one ran $18.70 per ton, principally in gold.

About one-half mile west of the Big Springs mine is another old property. Here the ore zone, which probably contains gold and silver, occurs in quartzite and shale and has a north strike with a vertical dip. Two caved shafts, 60 feet apart and probably totaling 200 feet in depth, appear to be connected by a stope to the surface. The stope indicates an ore width of about 18 inches.

Near the head of Marble Canyon, above Marble Falls, in the northwest part of the district, much shallow work has been done on narrow veins containing partly oxidized argentiferous galena.[72] Small shipments have probably been made by "chlor-iding" the silver-enriched surface ores. The lead content of the ore is usually about 10 percent.

The Eagle group, a tungsten prospect located by Charles Hammock of Mina, lies about one-quarter mile north of Ellsworth. Quartz veins containing wolframite are found in granodiorite. The workings, including a 60-foot inclined shaft and several more shallow holes, appear to be quite old. One news item mentions that J. L. Corlett did some work here in 1931. Specimens of wolframite were found on the dump of the 60-foot shaft; however, no estimate of the quantity of tungsten can be made as the wolframite has been sorted out for years by specimen hunters.

The Esta Buena patent, owned by Thad Holcomb of Reno, lies about one-quarter mile south of Ellsworth at an elevation of 7,200 feet. The nearest road point is at Ellsworth, which is also a source of water. It is reported that the last operation of the property was during 1924–1929. Couch shows a recorded production of $16,727 from 284 tons in 1872–1874. The ore contains silver bearing tetrahedrite occurring in a 3-foot quartz vein dipping about 45° W. into the hillside. It appears that the vein is in a thrust fault shear zone between granodiorite and limestone, the granodiorite being thrust over the limestone. The workings consist of an inclined shaft on the vein, now caved, which is said to have connected with an old adit at a depth of 284 feet. During 1924–1929, Otto Herz drove a 615-foot adit below this in an attempt to tap the old workings. This work is said to be 130 feet short of its objective and is now caved about 75 feet from the portal. Ore on the dump of the inclined shaft shows much tetrahedrite and it is reported that the dump will average about 10 ounces silver per ton. Some galena was found on the dump of the adit.

The Kohinoor patent is situated about one-half mile southeast of Ellsworth. The property has apparently been abandoned for many years and belongs to the county. A caved shaft has water to about 70 feet of the surface and a dump that indicates about 1,000 feet of workings. The dump material is all granodiorite with some quartz containing pyrite, the oxidation of which gives the whole dump a yellow color. Nothing indicates any production having been made from the property.

[72] Information from Mr. Conrad Martin, Geology Department, University of Nevada.

The Easter Sunday group, owned by W. F. and Mary H. Browder of Fallon, lies about 1 mile west of Ellsworth and one-half mile north of Ellsworth Canyon. A road goes directly to the property. An easterly bearing vein dipping 70° S. has 12 inches of quartz occurring in a highly altered greenstone. The principal workings consist of three shafts 40–60 feet deep on the same vein and within a short distance of each other. The property has produced 32 tons that averaged $57 per ton, principally in gold.

The old Flagstaff mine, relocated as the Eary group in 1928 and now owned by Don Benton of Salt Lake City, is about 1 mile northwest of Ellsworth on the north side of Flagstaff Canyon. A road goes directly to the dump of one of the principal workings. News items state that in 1935, ore from here was milled by J. L. Corlett in a small mill he operated at the lower end of Ellsworth from about 1933 to 1944. As the mill was used for ore from other properties in the area, it is not possible to determine how much came from the Flagstaff. It is reported that ore from here was milled by Corlett from about 1933 to 1940. The vein is a completely silicified shear zone in limestone; it bears S. 45° E. dips 45° NE. and is 2 to 4 feet wide. Workings consist of a long adit, an inclined shaft, and several cuts all tracing the vein for a thousand feet or more. It appears that no new work has been done here for many years. It is reported that 30 tons of ore carrying $55 per ton, principally in gold, was shipped from here in about 1940. No new work has been done in several years.

The Return mine, reported to be one of the early day producers of the Ellsworth area and relocated in 1934 by James Ford of Ione, is situated 2.5 miles west of Ellsworth at an estimated 7400-foot elevation. A vertical shaft, which has water to within 15 feet of the surface, is said to be 236 feet deep and to have about 1,000 feet of laterals. It is reported that lessees made some production from this property, but none is recorded. The ore occurrence is principally silver minerals, auriferous pyrite, and tetrahedrite in quartz stringers. Sheared Tertiary rhyolite dykes cutting Triassic(?) meta-volcanics appear to be the favorable ore zones.

The old Clinton Baird property, reportedly located by the Smith brothers of Gabbs, is just south of the summit on the old Gabbs Valley-Ellsworth road and about one-half mile southeast of the Return mine. A 3-foot shear zone, from which a small spring flows, has been traced and explored by shallow shafts and trenches which are now caved. A recently rehabilitated 70-foot shaft,

sunk in a highly altered volcanic, appears to be on the same general structure. Trenching the property with large excavation equipment, with the objective of developing a large tonnage of commercial gold ore, apparently was not successful as the equipment was only used a very short time. It appears that little or no production has been made from the property.

The Nut Pine, a lead-silver prospect located in 1926 by James Ford of Ione, is one-half mile northwest of the Return. The ore is highly oxidized, containing only occasional nodules of galena in an irregular replacement of calcareous shales interbedded with quartzites. The ore strikes east and dips 45° S. Only shallow work has been done and apparently little or no production made.

A mercury prospect about 1 mile south of Ellsworth was last worked by W. F. Browder of Fallon. The cinnabar, occurring irregularly distributed in a highly altered rhyolite, was explored with a short "grass root" adit. No production has been made.

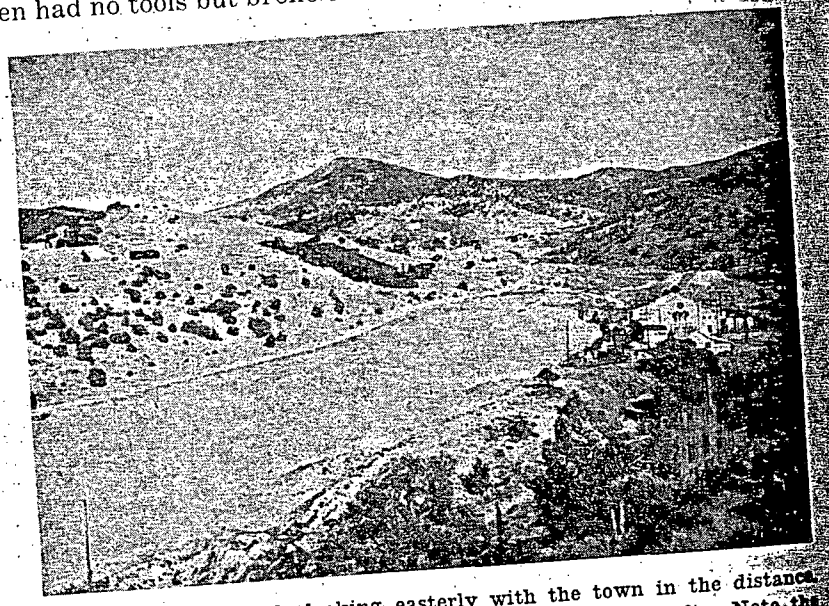
The Gabbs Valley tungsten claims are situated about 1½ miles south of Gabbs on the west slope of the Paradise Range. The claims were located by Albert Brown of Gabbs and prospected by him from 1931 to 1944. He states that irregular scheelite occurrences were found in narrow quartz veins in shale near a contact with granodiorite. Two short drift adits and a 260-foot cross-cut adit show some scheelite mineralization at depth, but the occurrence is too sporadic and was abandoned.

The Finger Rock mercury prospect, described by Bailey and Phoenix, is situated about 6 miles south of Gabbs. Ownership, if any, is unknown. The cinnabar, occurring with jarosite in a breccia, was discovered in 1934 by Clyde Garrett. In 1936 a later owner treated ore from here in a 20-ton portable rotary furnace. In 1943 the property was idle. The workings include a small dry hole with adit, a 250-foot adit, and several shorter adits.

MANHATTAN

The Manhattan mining district lies at the southern end of the Toquima Range in the vicinity of the town of Manhattan, which is 50 miles by road north of Tonopah. Of this distance 47 miles is paved, State Route 8A, and the balance is an improved graveled road. The town is situated at an altitude of 7,000 feet. It obtains transmitted electric power from the California Electric Power Company, and phone service from the Nevada Telephone-Telegraph Company. Although winters are severe, mining usually continues throughout the year.

The discovery of Manhattan, as related by Mr. Walter Bowler of Tonopah, took place in April 1905. John C. Humphrey, E. E. Seyler, "Shorty" Mott, and unknown party stopped to eat lunch on the road between Belmont and the Seyler ranch on Peavine Creek. While resting after lunch, Humphrey looked around the area a bit and within about 100 feet of the road broke specimen-grade gold ore off an outcrop. Not believing what he found was gold, he asked his companions who assured him it was. The four men had no tools but broke off what rock they could and continued



(11) Manhattan Gulch, looking easterly with the town in the distance. Mustang Hill and the War Eagle mill are on the left. Note the upper end of the dredging opposite the power sub-station.

to Seyler's ranch, returning with a six-horse team and provisions. Several claims were staked and the Humphrey-Seyler Company was organized. Mr. Bowler states that the men netted $800 each from the original ore they broke off the outcrop of the discovery.

Although Humphrey and the others are usually credited with the discovery of Manhattan, it is conceded that other work had been done in the area before 1905. Thompson and West mention an ore discovery in 1866, but state that little was done after 1867. Regardless of this early work, the discovery of the high-grade gold ore in 1905 started the activity that made the district.

The discovery of placer in the Manhattan district is described by C. C. Jones.[73] He reports that the first gold colors were found

[73] Notes on Manhattan Placers: Eng. Mng. Jour., July 17, 1909, pp. 105-

well in 1905, and the first nuggets were found on the surface by a miner named Burns. In April 1908 William McDonald, a California placer miner believing the gravel would pay, sunk a 23-foot shaft to bedrock, finding 5 to 7 feet of $10 per yard gravel. This started placer activity and several other shafts were sunk, including one by Thomas (Dry Wash) Wilson who found a few large nuggets. Jones states that during May 1909, over $1,000 per day was produced by crude placering methods.

Although Manhattan boomed soon after Humphrey's discovery, its early life was short. It seems that a large percentage of the people and money interested here were from San Francisco, and that city's earthquake and fire of 1906 had a direct effect on the economy of Manhattan. Mining capital was cut off immediately and those men mining here who had families and friends in San Francisco returned to lend aid. Couch's production figures indicate that very little mining was done prior to 1911.

The total recorded production from the Manhattan district, as shown by Couch, is $10,362,289 to the end of 1949. Of this amount the lode mines produced $5,765,862 from about 402,300 tons, and placer mining by the Manhattan Gold Dredging Company produced $4,596,427 during 1938–1946. Although the total yardage washed is not known; incomplete figures indicate an average yield of about 21 cents per yard. Considerable placer mining production was probably not recorded as much of this was done by small operators.

The dredge was by far the largest producer in the district, and the White Caps Mining Company was second with a recorded production of $2,635,008 from 144,043 tons during 1918–1940. Another large producer was the Reliance Mining Company which had a recorded production of $1,077,939 from 59,108 tons during 1935–1941. Lessees have made nearly all the lode production from the camp since 1940.

The dredge was the last large operation. It shut down in September 1946 and during the next year was dismantled and moved to Copper Canyon near Battle Mountain. The Reliance Mining Company was the last lode mine to operate on company account. The company stopped operations in about 1940, but lessees continued working the mine for about a year.

Geology. The following excerpts[74] from H. G. Ferguson's outline of his detailed report give the general geology of the Manhattan district gold deposits.

[74] Geology and Ore Deposits of the Manhattan District, Nevada: U. S. Geol. Survey Bull. 723, pp. VII–IX, 1924.

Manhattan is in the southern part of the Toquima Range, about 35 miles north of Tonopah. The geology is extremely complex. The southern part of the district is underlain by closely folded Paleozoic rocks. For purposes of mapping these have been divided into five units, to four of which local names have been given. The oldest of these units, probably of Cambrian age, consists dominately of siliceous mica schist but contains beds and lenses of quartzite and dark sandstone and five beds of crystalline limestone. The total thickness exposed is estimated to be about 5,000 feet. Above this, and provisionally assigned to the Ordovician, is about 800 feet of chloritic schist, altered by thermal metamorphism to "knotted" schist. This unit in turn is followed by 800 feet of gray limestone, partly altered to black jasper, which near the top grades into black slates. The lowest fossiliferous stratum is a thin bed of black slate containing graptolites, which is separated from the underlying limestone by a thin layer of quartzite. The graptolites are of Normanskill (Ordovician) age. Above the graptolite bed is limestone similar in character to that below, followed by a great thickness of chloritic schist, with here and there thin beds of cherty slate and crystalline limestone. The total thickness of this group of beds probably exceeds 4,000 feet in the area mapped.

There are also isolated outcrops of sandstone, in which fossils of probable Permian age have been found.

Granitic rocks intrusive into these sediments and probably of early Cretaceous age occupy a large part of the range to the north and south of Manhattan. Although these granitic rocks crop out over only a small part of the area mapped in detail in connection with this report, the older sediments are everywhere more or less metamorphosed, and siliceous aplite dikes are abundant within them.

Tertiary rocks occupy the northern part of the Manhattan district. Most of them are correlated, chiefly on lithologic grounds, with the Siebert formation of the Divide and Tonopah districts and are therefore inferred to be of upper Miocene age. The oldest member is a breccia made up of fragments of the older rocks and believed to be an ancient cemented talus deposit. This

is followed by rhyolite and rhyolite tuff, then by porphyritic rhyolite and a considerable thickness of lake beds, and these in turn by quartz latite. Later came intrusions of rhyolite and andesite porphyry. The youngest of the volcanic rocks is a flow of dacite, probably of Pliocene age, in the northwestern part of the district.

The Paleozoic rocks are closely folded. The principal anticline, which brings the Cambrian(?) rocks to the level of the present surface, is overturned to the north and truncated by a fault that has thrust the lower part of these rocks above those of probable Ordovician age. The latter rocks are themselves compressed into close folds that pass forward into a large overturned syncline. The upper contact of the Cambrian(?) formation is masked by a normal fault.

The granite intrusion appears to have had little effect on the structure, though some of the minor normal faults in the productive part of the district may have been initiated at this time.

The lode deposits of the district belong to two different periods of mineralization, one following the granite intrusion and the other of late Tertiary age. The deposits of the earlier period consist of sulfide-bearing quartz veins and are not industrially important in the Manhattan district. The deposits of the later period include veins in the Tertiary lavas and intrusive rocks and the deposits in the Paleozoic rocks that by their texture and mineral composition indicate formation at shallow depth.

The veins in the lavas consist principally of comby quartz with pyrite and a little free gold and have so far been only slightly productive. To the same type, however, belongs a deposit of silicified tuff, which has been quarried for use as tube-mill pebbles. (See Belmont district.)

The shallow vein deposits of the Cambrian(?) schist have been the most productive of the district. They consist of comby quartz, adularia, and tabular calcite replaced by quartz and adularia, and they carry free gold. In some places they form a network along the bedding and jointing of the schist; elsewhere they form definite lodes.

The ore deposits in the Cambrian(?) limestone are mineralogically both complex and varied. Mineralization of economic character has been largely confined to the third of the five limestone beds. The limestone is cut into small blocks by normal faults. The larger of these faults are of postmineral age, but many of the smaller ones appear to be closely connected with the mineralization. Among the more abundant gangue mineral are coarsely crystalline calcite, fine grained quartz, fluorite, sericite, leverrierite, and adularia. The metallic minerals include realgar, orpiment, stibnite, pyrite, arsenopyrite, and free gold. It is thought probable that two periods of primary mineralization are represented in these deposits.

Downward enrichment appears to have produced much of the extremely rich ore mined in the early days of the camp and is believed to have taken place in certain of the ore bodies in the Cambrian(?) schist, even at considerable depth.

The overthrust fault, though older than the productive mineralization, appears to have been a notable factor in the localization of the ore deposits, for the principal mines all occur on the hanging-wall side and not far from the fault itself. Smaller normal faults of later date appear to have furnished channels for the ore-bearing solutions, and faulting later than the mineralization has added to the complexity of the structure.

The unproductive veins are believed to be of Cretaceous age. The younger deposits, on the other hand, can not be older than late Miocene nor younger than late Pliocene. Apparently in the later part of Miocene time there was considerable metallogenetic activity throughout the Basin Range region.

The limestone ores show several features in common with the vein deposits and are probably of the same age, though the realgar and stibnite may represent a later stage of Tertiary mineralization, and there is some evidence that the formation of the coarse white calcite, the earliest mineral of the deposits, dates back to the time of the granite intrusion.

The occurrence of the lode deposits in pipe-like shoots in the Cambrian(?) schists and limestones should be stressed. This

condition is particularly noticeable in the western part of the district.

Properties.—Information on the Manhattan mines was obtained largely from Mr. Robert W. Prince of Reno, who has in his files data on several mines of the district. Mr. Charles Dearing and Mr. James Larsen, who have done much work in the area, also aided greatly with their knowledge of recent activity.

The Reliance mine on Manhattan Gulch in the western part of the district, now owned by Mark Bradshaw and Hugh S. Van Wagonen, is on ground including a claim formerly known as the Copenhagen, located in April 1905, and lies just east of the Manhattan power substation. The Reliance ore body, which is on what Ferguson refers to as the Little Gray vein, was discovered in about 1932 by Charles Dearing, Matt Kane, and another party, who sunk a shaft through about 60 feet of gravel and found the vein in the bedrock. Its presence was suspected as the Little Gray vein was first worked in 1910 on the Little Grey claim.

The Reliance shaft is 464 feet deep, vertical, and has about 4,000 feet of workings. The main workings are above the 365-foot level and stopes extend to the bedrock surface, which has 50–70 feet of gravel above. The vein strikes northwest, dips nearly vertically, and occurs in limestone and slate of the upper Cambrian(?). The gold is associated with quartz, calcite, and fluorspar.

The total recorded production, as per Couch, is $1,077,939 from 59,108 tons during 1935–1941. In 1941, after the ore bodies were largely depleted and the owners were unable to agree, the property was shut down. In 1946 the shaft buildings were removed preparatory to the dredging of the ground in February 1947 by the Manhattan Gold Dredging Company. This flooded the workings and filled the shaft with debris. As the upper levels had stopes into the gravel it may be assumed that they also are now filled.

The Gold Metals mine, owned by the Burdick-Wittenburg estate, is on the north side of Manhattan Gulch in the western part of the main lode mining area. This ground adjoins the Reliance Thanksgiving properties on the northwest. Much work has been done here on what is apparently the continuation of the Little Grey vein which passes through part of the Thanksgiving ground between the Reliance and the Gold Metals.

The principal recorded production, as shown by Couch, was made during 1935–1936 when $87,450 was produced from 9,372

tons here in 1941–1942. This latter ore was milled in Francisco's mill on the Indian Camp group.

The Gold Metals ore occurs in Ordovician limestone and the area in the vicinity of the vein is badly fractured. That ore which Francisco mined was allowed to cave and then drawn from chutes. Nothing is known about the continuation of the Little Gray vein to the northwest into Black Mammoth Hill. The Gold Metals has a 300-foot vertical shaft completely equipped with buildings and machinery, some of which is antiquated but useable.

During 1942–1949, Byron Wilson, Charles Deering, and Bud Priester sank a 122-foot shaft by windlass on the Little Gray vein near the Gold Metals shaft. They were following a 2- to 8-inch width of high grade from which 12 tons of sorted ore, shipped in 1938, grossed $3,792. In 1949 they recorded a production of $185 from 19 tons which apparently was a trial shipment of unsorted ore.

The Little Gray patented lode claim, owned by the Burdick-Wittenberg estate, was located in April 1905. This claim adjoins the Reliance group on the southeast. The Little Gray vein is opened by a 400-foot inclined shaft with about a mile of workings, and has been inaccessible for many years. As the shaft passes through 50 feet of gravel, the vein was probably first found elsewhere on the claim. Very little lode mining has been done here for many years, although it is believed that placer on this claim has been worked intermittently and some residual placer is still left.

Ferguson[75] reports that the main ore shoot had a maximum length of 100 feet, was 5–20 feet wide, and was mined from the surface nearly to the 300-foot level. The vein occurs in a mica schist with some slate and quartzite which are all of upper Cambrian(?) age. Most of the production was made by lessees in the early days and little was recorded. Ferguson refers to one of the early day leases that yielded $120,000 in ore averaging $22.50 per ton.

The property of the Thanksgiving Reorganized Mining Company consists of the Thanksgiving fractional lode and the Orphant patent. The Thanksgiving was located in 1906. This ground lies on the western part of Mustang Hill, adjoining the Gold Metals claims on the southeast and the Reliance and Mustang on the north.

Part of the Little Gray vein is on the Orphant claim and was worked through the Reliance shaft in about 1939. Mr. Prince

[75]U. S. Geol. Survey Bull. 723, p. 145.

believes that about $5,000 production may have been made from the Little Gray vein on the Orphant claim. He believes that placer deposits on high bars in the southwestern part of the Orphant may have produced about $10,000. George Rong and Albert White made a small shipment from a lease on the western part of the claim in January 1949. They sunk an 80-foot shaft and drove short levels on mineralized fractures cutting carbonaceous limestones and shales.

Work on the Thanksgiving vein on the Thanksgiving Fraction was started about 1910 and abandoned a few years later. A 65–70 degree inclined shaft 450 feet deep was sunk on the vein. In about 1937 the Reliance Mining Company unwatered and sampled the workings. They also connected the 200-foot level with the Mustang shaft.

In 1946 the Jefferson Lake Sulphur Company, under the supervision of Robert W. Prince, unwatered the shaft again and sampled the workings. Mr. Prince states that the previous mining had been on a pipe of ore 18 inches to 14 feet wide, with 50 feet maximum length on the strike, and extending from the 326 to 226-level. He estimates that about 200 tons of ore were removed. As per a letter written by L. P. Stevens in 1922, $3,299 was grossed from 179 tons when he operated the mine in 1912. Stevens shut the property down at that time. No recorded production is shown from the property.

The Thanksgiving vein occurs in the upper Cambrian(?) formation with Ordovician limestone at the surface. The ore is found in pipe-like replacement shoots which, however, are infrequent, due to the tight condition of the formation. The vein itself has a maximum width of 12 inches, is quartz-filled, and nearly barren. The White Caps limestone is about 1,000 feet below this, therefore, some speculation exists as to what the vein may do at such depth. On the 400-level, an altered rhyolitic igneous rock was found. Neither its classification nor origin is clear; it may be a dike or a down-faulted segment of similar rhyolite found elsewhere on the surface.

Water stands in the Thanksgiving shaft about 20 feet below the 200-level, which connects with the Mustang shaft 215 feet distant. In addition to this level there are about 800 feet of workings.

The Mustang mine, now owned by Mark Bradshaw and Emmett Q. Yates, was originally located in April 1905 as the Mustang claims, and relocated in 1922 by Matt Kane and Yates as the Midas group. The surface workings are characterized by large trenches

on the ore zone across Mustang Hill. These cuts are said to have produced about $10,000. Previously worked pipe-like shoots in the zone extend in a gopher-like manner to a 200-foot depth below the cuts. These underground workings total about 1 mile and although they do not connect, they come within a very short distance of the Mustang shaft, which is about 350 feet west of the cuts.

The Mustang shaft is on the Mustang vein which occurs in Cambrian(?) limestone and is parallel to the Thanksgivng vein. The ore here is also found in pipes. A large number of surface workings indicate many small seams and veins on the Mustang ground.

The Mustang shaft is 275 feet deep with about 600 feet of workings on three levels, in addition to the 229-foot level which connects with the 200 of the Thanksgiving shaft. Water stands just below the level. This shaft was retimbered by the Reliance Mining Company in about 1937, and again by the Jefferson Lake Sulphur Company in 1946. Mr. Prince states that a small inclined stope from the 275 level almost to the 225 level and another from the 230 level to 50 feet above the 190 level could have been the source of 500 to 1,000 tons of ore. Ferguson states that the principal pipe produced a reported $40,000. This group has no recorded production.

Improvements on the Mustang ground consist of the War Eagle cyanide mill, a house, an office building, and several buildings and usual equipment at the shaft.

The Stray Dog and Jumping Jack claims, owned by Arthur Hudson of San Francisco, lie about one-half mile south of the Manhattan power substation. These claims were among the earliest worked in the camp and, as shown in Mineral Resources and mentioned by Ferguson, produced during 1906–1913. Mr. Hudson has old records showing a production of about $122,000 during 1910–1919, which was made from ore that averaged about $20 per ton. Other of his records show about $8,200 production during 1939–1941 from small lots of high-grade ore shipped to the Gold Point mill near Lida. Most of this ore contained $50 to $440 in gold per ton. In addition, Charles West, a lessee, deposited about $9,100 of bullion with the mint during 1937–1938.

Ferguson mentions that the ore on the Stray Dog occurs in schist and may be on the Union No. 9 vein. He notes that the values decrease greatly with depth. The ore here has been explored by a 240-foot shaft with about 1,000 feet of workings and two other shafts less than 100 feet in depth.

Hudson has just finished constructing a small amalgamation mill with which he plans to treat the ore from the Stray Dog claim.

The Jumping Jack claim is on a crushed zone which has been worked from a 165-foot inclined shaft. Small veinlets occur in the schist and, although low grade when mined across wide widths, the ore may be somewhat concentrated by screening. This ore zone is most prominent on the Big Pine and other claims to the east which will be described.

The Big Four, Big Pine, Mayflower, and Reilley Fraction claims; the last three mentioned being patented claims belonging to the Burdick-Wittenberg estate, form a group containing a wide zone of stringers which may be concentrated by screening. The claims lie west of what is known as the Pipe Spring road, and are one-half mile south of the town of Manhattan.

The group is well-described by Ferguson[76] who states that the Big Pine had a probable production of $300,000, most of which was made during 1914–1917. He notes that an estimated $100,000 was mined from the Reilly Fraction and although the other claims have produced, the amounts are not known. Apparently none of this production was recorded with the State.

Ferguson states that the ore occurs in narrow veinlets having a definite pattern along joints in the schist, shale, and quartzite. Their width is usually less than one-eighth inch and never over one-half inch. It has been found that the veinlets are relatively loose near the surface and when the mined material is screened the vein material goes into the fines.

These claims were mined underground in the early days but the later mining by glory hole and cuts on the Big Pine and Big Four was of greatest consequence. Ferguson notes that in 1915 the Big Pine was milling 200 tons per day, obtained from 450 tons mined at a cost of about 46 cents per ton. He states as follows:

> The material mined was coarsely crushed, and the oversize, above five-eighths of an inch, was rejected. The tenor of the ore mined was about $5 per ton. The rejected oversize material was reported to carry less than $1, and the portion milled about $10. The average width of the ore body is between 40 and 50 feet, and the maximum about 75 feet.

Ferguson adds that in 1919 the deeper ore was of lower grade and also no longer exhibited the tendency to break free of the

[76] U. S. Geol. Survey Bull. 723, pp. 139–143.

enclosing rock. The general depth of the glory holes and cuts was about 50–75 feet. Mr. Prince reports that the total length of the glory holes and cuts is about 900 feet and they are distributed over about 2,000 feet of the ore zone.

The A. O. Smith Company did much sampling here in about 1937 and is said to have been agreeable to work the property, but considered the Wittenberg price too high. This group appears to have potentialities for a high tonnage, low-grade operation.

The last work done here was on the Big Four by Emerson J. Hyde, who recorded a $15,160 production from 291 tons during 1941–1946.

The White Caps mine, controlled by the Cole-Kirchen estates, has been the most important producing lode mine in the Manhattan district. Couch shows a recorded production of $2,723,267 from 151,668 tons during 1912–1940. The latter part of this production is said to have been made largely by lessees.

The primary ore of the quartz vein contains extremely finely divided gold associated with realgar and stibnite. Cyanidation gave a successful 90 percent extraction on the oxidized ore extending to a depth of 150 feet, but only 50 percent on the sulfide ore.

In 1917 the White Caps Mining Company took over the mine with John G. Kirchen as manager. A seven hearth furnace was added to roast the ore under certain controlled conditions preceding cyanidation. The analysis of the milling ore was stated to be under 1 percent each of arsenic and antimony yet the extraction of the gold was very unsatisfactory, and this plant tailing was also a metallurgical challenge to cyanide retreatment plants in after years.

Director Carpenter states the vein occasionally contained large lenses of both pure realgar and pure stibnite, giving stope faces up to 4 feet wide and 20 feet in length, that were beautiful to behold but carefully avoided for mill ore, and not even recorded on the mine maps. However, it is probable that the arsenic and antimony content of the mill ore was at times considerably higher than the stated "average," accounting for erratic roasting and cyanidation results.

Ferguson states that after the mill was closed down in 1920, shipments of realgar were made. Of 1,500 tons shipped the arsenic content was 669,392 pounds, and the shipments also contained $38,146 in gold. The mill reopened in 1922 but closed again in 1923. In 1935 or 1936 a flotation mill was built but was destroyed by fire shortly after its construction. During the last war another 8 tons of the arsenic ore was shipped from the 600 level.

The White Caps shaft is vertical and 800 feet deep; from here the 1,300 level of the mine was reached by a winze. As the ground is heavy the lower levels were abandoned to the 1100-foot level. Water is now said to stand at 400 feet in the shaft.

The ore occurs in what is known as the White Caps limestone, an upper Cambrian(?) formation. The veins are badly faulted across their strike. The ore shoots have better continuity down the dip than they have along the strike. The stopes indicate that some of the ore widths were 5–7 feet.

Ferguson states that the greatest abundance of realgar is found between the 450 and 665-foot levels in the eastern part of the mine. He adds that stibnite occurs throughout the mine but is more prominent in the western ore bodies, particularly near the 310 and 450-foot levels. As the interest in antimony is much greater now than at the time the White Caps was operating, the location of the high-grade stibnite lenses of the vein would be of value.

The mine plant was left complete and in working order; however, much of the smaller movable items have been pilfered. The cyanide mill, with its furnace, is still on the property.

The Manhattan Consolidated mine lies west of the White Caps and is about 1 mile southeasterly of the town of Manhattan. It is owned by the Burdick-Wittenberg estates. The ore occurs very similarily to the White Caps', although the silver content is higher. A 500-foot vertical shaft is said to have water about 100 feet below the collar. Couch shows a recorded production of $249,530 from 3,236 tons made during 1936–1940. The small concentrating mill on the property was used to mill the Gold Metals ore in 1935–1936.

The Amalgamated mine, also owned by the Burdick-Wittenberg estate, lies just southeasterly of the town of Manhattan. It is recognizable by the remains of a rail tramway that was used to bring ore down and supplies up a steep hillside to the shaft. The property has a 500-foot vertical shaft with water standing at about the half-way point. It is said to be equipped with an old hoist and large compressor, and has a few buildings in poor condition. Ferguson mentions a reported production of $183,848 from 9,615 tons to 1915, and that nothing had been done since 1918.

The April Fool claim, part of a group belonging to the Seyler-Humphrey Mining Company, is the original claim in the Manhattan district. The company was formed in about 1916 and work has been largely by lessees. The workings are all shallow, a 100-foot adit with a total of about 400 feet of laterals being the

principal work. This adit lies just north of Manhattan Gulch and the town, and is south across a smaller canyon from the Selig mill which was built for ore in this vicinity. Vein zones strike both northerly and easterly, with the north bearing veins of greatest importance. Ferguson states that the spectacular high-grade ore was within 30 feet of the surface and the workings seldom went below 80 feet. The old excavations are now largely caved.

The Keystone mine, owned by Jim Nelson, is situated in the floor of a small canyon about 4 miles by road south of Manhattan. The ore occurs in a talus breccia cemented with calcite, quartz, and fluorite. The talus lies on and next to a schist which is sometimes mineralized with gold near the contact. The aggregate materials in the talus are limestone, shale, chert, quartzite, and schist. The Reliance Company hauled much of this material to the War Eagle mill and the heads averaged $7 per ton. During 1950 the Larson brothers shipped 250 tons which averaged $10 per ton. The property is opened by 60- and 45-foot shafts connected by 75 feet of drifting. Mr. Prince states that sampling indicates 15,000 to 20,000 tons of $7 ore.

The Jumbo mine lies west of the Keystone, and is owned by Joe Francisco who is said to have made some production from here in 1937–1940. The ore occurs in schist near a granite contact and was mined from a glory hole. About 1,500 feet of work has been done off the glory hole adit. The ore was milled at Francisco's mill on the Indian Camp claim.

Emerson J. Hyde was leasing on the Crescent patent, part of the Burdick-Wittenberg estate, in April 1950. He was mining in a 65-foot shaft following narrow seams in the schist. He has as yet made no production from here.

Hyde's hoist, which he uses on this work, is well worth noting as it is an unusual but practical application of a double clutch hoist arranged for one-man control from underground. The 6-horsepower hoist operates on the surface in the conventional manner but is controlled by two ropes, one for each direction of the clutch, from the shaft. The speed of the bucket is reduced in half as the end of the cable is anchored at the headframe sheave and passes over a single block at the bucket, then over the main sheave. The slow speed allows the use of less power and is safer. The bucket is not dumped from below, as the operator rides the loaded bucket up and dumps it from the surface. This allows a periodic inspection of the hoist and compressor. The brake is set with enough drag so that the clutch must move the drum in order

to move the bucket either up or down. A third rope, which controls the hoist brake, is only used to secure the bucket and prevent its movement by unauthorized operation of the clutch at the surface.

Bud Priester has some claims about 2 miles west of Manhattan on the north side of the main gulch. Shallow work has been done on gold ore occurring in pipes in limestone. The improvements consist of a cabin.

John L. James of Battle Mountain has a property containing turquoise occurring in Ordovician limestone on the northeast side of Black Mammoth Hill. It is believed that the gem material was mined, cut, and polished by the owner.

The Original Manhattan Mines Company, represented by C. C. Boak of Tonopah, has two patented claims on the south side of Black Mammoth Hill. Mr. Boak states that a brecciated zone in limestone has gold values in the seams and interstices of the breccia. He states that the zone is 60 to 250 feet wide and contains 75 cents to $6.25 per ton in free gold.

The Manhattan Gold Mines Company property is in the eastern part of the district near the crest of the range. It has transmitted electric power which is used for the compressor, blower, and small equipment. Water must be hauled from Manhattan. Couch shows a recorded production of $30,469 from 1,027 tons made by R. E. Williamson during 1945–1948. The ore occurs in seams and veins from knife-blade to 3-foot width in limestone. Quartz and calcite are the principal gangue minerals. The principal work is a 1,400-foot adit with stopes and raises to the surface.

A rather novel equipment installation here is an underground high grade mill built by R. E. Williamson, who has a lease on the property. The mill is a small ball mill used to amalgamate high grade during the winter months. As the temperatures do not go below freezing in the workings, the mill is very satisfactory for winter work. Some water is obtained by melting snow in an improvised tank outside. During the summer months, milling is done in a 5-stamp mill west of Manhattan. It is believed that Williamson made some production from here in 1950.

The Otero group, being intermittently explored by R. W. Fletcher of Chicago, lies just north of the Manhattan Gold. Two adits with a total of 700 feet of work have been driven in search of favorable structures for ore. To date no ore has been found.

The Jurick mine is along the Belmont road just east of the Otero group. A 35-foot shaft and 100-foot adit have been driven

on gold occurrences in rhyolite. About 40 tons of $18 ore is said to have been shipped from here in about 1940.

Placer Deposits. Ferguson[77] summarizes the Manhattan placer deposits as follows:

> Placer gold is found in the older gravels, of which remnants exist in places along the sides of the gulch above the present fill; in deeper gravels of the present gulch; and in recent hillside wash. The older gravels have been worked in only a few places. The bulk of the production has come from the gravels that rest on bedrock in the gulch itself, at depths of 40 to more than 100 feet. This gravel, as shown by the fossils found in the mines, has remained undisturbed since Pleistocene time. The gold content is variable; in a few places the pay gravel yielded over $50 to the cubic yard, and in most of the productive mines the yield was over $2 to the yard. The purity of the gold as measured by the bullion returns increases regularly downstream and in the 2 miles of developed ground changes gradually from an average fineness of about 700 to 740. This change is believed to be due to the fact that downstream the gold particles are smaller and present a greater proportionate surface to the action of solvents in the water. As the gold has remained undisturbed for so great a length of time the solvents have had an unusual opportunity for refining the gold.
>
> A little gold has been obtained from the recent hillside wash in the vicinity of the mines in the Cambrian(?) schist.

As easily eroded high-grade veinlets are common in the area it is to be expected that placer deposits of one type or another would be found well distributed. Such is the case, as placer workings may be found almost anywhere in the district. It is quite likely that the better material has already been treated; however, we may expect that limited placer mining will continue in the area for a long time. Should general economic conditions ever return to what they were in the early thirties, Manhattan is apt to have many placer miners again using various schemes to obtain and wash the gravel. The Nevada State Bureau of Mines bulletin, Placer Mining in Nevada, written by W. O. Vanderburg in 1936, describes the mining and washing methods used in this

[77]U. S. Geol. Survey Bull. 723, p. IX, 1924.

area. The bulletin is now out of print but may be consulted in many libraries.

The Manhattan Gold Dredge Company not only conducted the most important placer operation in the district but was also the largest producer of gold in the history of the district.

The dredge was built during the summer of 1938 at a cost of $700,000. An additional $300,000 was spent for pipe lines, pumping equipment, and a camp. Stripping equipment was in addition to these costs. The dredge started operating in 1938 with plans to wash 25 million yards of gravel. The operation was under the supervision of John L. James.

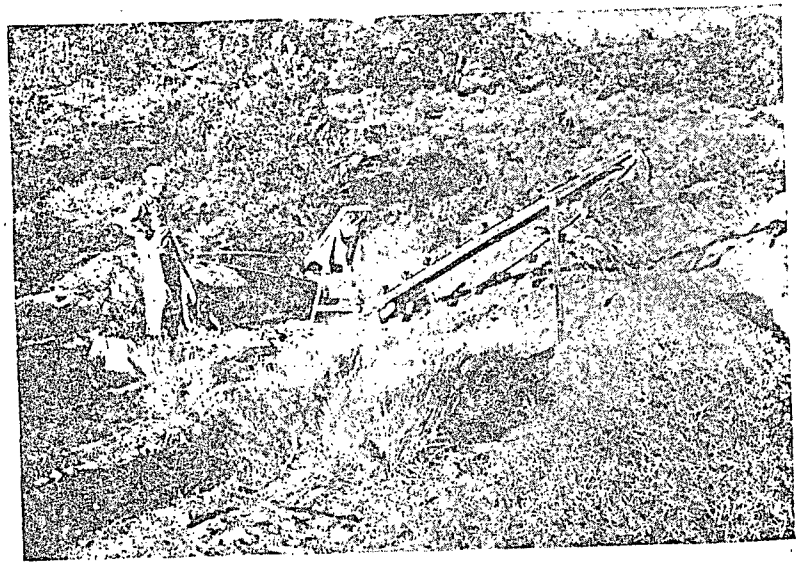
The boat was 172 feet long, exclusive of tailing stackers and bow gantry. It had a 60-foot beam and drew 9 feet of water. The 9½ cubic-foot buckets operated at a speed of 37 buckets per minute and could dig 75 feet below the water surface. The dredge weighed 2,000 tons, was electrically operated, and had a connected load of 2,200 horsepower plus the water pumping load. The total monthly power cost was about $8,000.

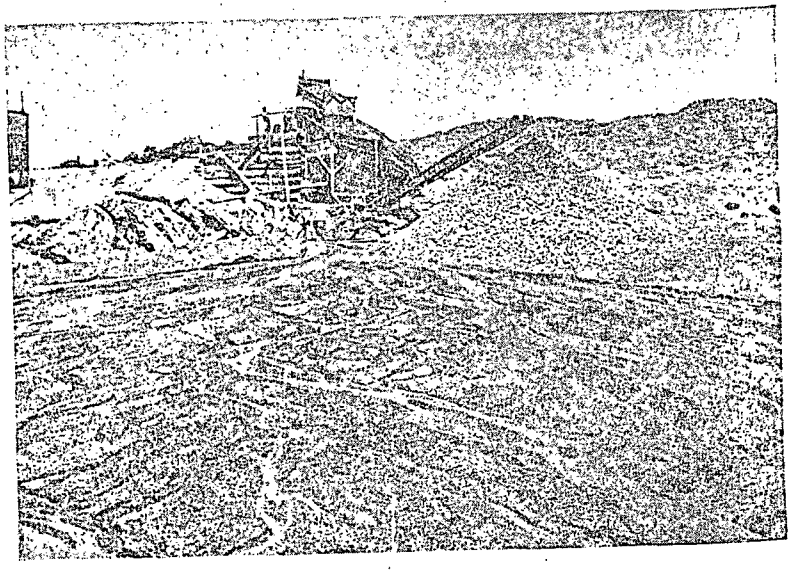
Gold recovery was made by the use of jigs, tables, and Hungarian riffled sluices. The jig hutch product was scrubbed in a Straub ball mill. Amalgamation was used extensively to retain the fine gold.

Manhattan Gulch was dredged from a point well out in the flat portion of the terrain to a point approximately east of the power substation. Dredging was stopped approximately on the Reliance mine ground in 1947. The dredge was disassembled and moved to Copper Canyon, near Battle Mountain, the move being completed in January of 1948.

Since the dredge left, a few small gravel washing plants have operated on high bars that the dredge could not reach. The latest of these is the Fehn-Johnson placer which was operating in 1950 about 5 miles below Manhattan. C. H. Fehn and R. E. Johnson of San Bernardino, and C. M. Pittser of Long Beach, started the operation in the spring of 1948. About 250 yards per day is handled in a semistationary plant. The gravel passes through a trommel with the plus ⅝-inch material being discarded. The undersize goes over a trap and two Pan American 42-inch, two-cell diaphragm jigs. The hutch product is dewatered and elevated to an 18-inch Pan American pulsator jig, which hutch product is barrel amalgamated.

The gravel is mined with a ⅝-yard shovel and hauled in a 6-yard truck. When the operation was visited in the summer of





(12) Present placering near Manhattan.
Upper. George Ruby using a gasoline-powered dry concentrator with a tailing stacker of his own design.
Lower. The Fehn-Johnson washing plant using jigs as the principal means of gold recovery.

1949 the truck haul was about 1,500 feet. From April to September of 1949 about 15,000 cubic yards had been washed.

Occassional small dry placer operations are still conducted in the district. In the summer of 1949, George Ruby, an experienced dry washer operator from the Johnnie district, was testing some of the gravel on the Jumping Jack claim. He was using a conventional dry washer coupled to a small bucket elevator for tailing removal, all operated by a 1½-horsepower gasoline engine. A little gold was found but the "pay streak" was too restricted and thin to pay. Placering had been previously tried in this area.

MELLAN MOUNTAIN

The Mellan Mountain mining district covers a small hill rising about 400 feet above the floor of Cactus Flat 13 miles east across the flat from Cactus Springs. This hill is the northernmost of a small range of such hills finally joining the south end of the Cactus Range 10 miles south. The district is about 38 miles east of Goldfield and 51 miles southeast of Tonopah. It is completely within the Tonopah Bombing and Gunnery Range.

No previous listing or description of mining districts within the State shows the Mellan Mountain mining district; however, among the mining fraternity the area is generally described by this name. It is too far from another district to be included and is, therefore, described here under the name commonly used.

The Mellan Mountain district was apparently discovered by Jess and Hazel Mellan in 1930. The locations were made by Hazel Mellan in October 1930.

Geology. S. H. Ball indicates the hill to be Tertiary Miocene rhyolite. Although a large part of the hill is a rhyolite, some being porphyritic, what appears to be a highly silicified shale is also quite prominent in the district. The rhyolite is believed to be both intrusive and extrusive.

The ore values are principally in gold with some silver and occur in shear zones in the rhyolite and shale. Sample results noted indicate the ore to be 4 to 6 feet in width.

Properties. The Mellan Gold Mines group is the property of principal consequence in the district. It is owned by a corporation controlled by Hazel Mellan of San Bernardino, California. A small production, amounting to about $1,000, is said to have been made from the claims prior to World War II.

The workings consist of a 400-foot 50-degree inclined shaft with levels at 40, 80, 160, 300, and 400 feet having 700 feet of laterals; and a 100-foot vertical shaft with 40 feet of drift on the

50-foot level and 600 feet of laterals on the 100 level. Some stoping was done on the better ore found on the 40-foot and 160-foot levels of the inclined shaft. Four samples taken in these stopes across widths of 4 to 6 feet contained $17 to $27 per ton largely in gold. A 100-foot adit has some ore of similar grade on the dump.

Improvements include headframes and hoist houses in good condition at each shaft with an ore bin at the incline. Several houses at the camp all appear to be in fair condition.

Other claims in the district are bare prospects with only minor workings.

MOREY

The Morey district is on the east flank of the Hot Creek Range, 4½ miles west of Moore's Station. The district is 22 miles northwest of a point on the Tonopah-Ely highway, 75 miles northeast of Tonopah. Roads to the area are usually in fair condition. The elevation at Morey is about 7,000 feet and snow conditions during the winter months can give some difficulty without proper equipment. Water is obtained from nearby springs and from the lower adit of the Morey workings.

Thompson and West state that the first discovery was made in 1865 by T. J. Barnes and the district was organized the next year. They report that the town of Morey was started in 1869, and in 1880 had five business houses and a population of 60. They add that a 10-stamp mill was built in 1873, but only ran one month. The ore was then shipped to Tybo until 1880 when the mill ran for about 7 months producing about $9,000 bullion per month. Raymond (1875) reports that the mill ran only part time as it was made of old machinery that was giving trouble. In the light of the refractory character of the ore it may be that the operation also met with much metallurgical difficulty.

Couch shows a rather consistent though usually small annual recorded production from 1867 through 1891, after which no production was recorded until 1937. Since then, various operators have made ore shipments except during 1943–1944. Couch's figure on total recorded production to and including 1948 is $475,117 from 6,467 tons. It is interesting to note the difference in the value of the ore produced prior to 1891 and that shipped in later years. During 1867–1891, recorded production is $415,662 from 3,163 tons, or $131 per ton; while during 1937–1948 $59,455 is reported from 3,304 tons, or $18 per ton. However, the value of Morey ore is principally in silver which dropped in value between these periods. The average value of silver during

1867–1891 was $1.16 per fine ounce, while the average value in the 1937–1948 period was only $0.50; therefore, the ore having a value of $18 per ton in recent years, would have been $42 ore in the early days. The relative quantity of silver contained was, therefore, in the approximate ratio of 3 to 1, which is still quite a drop.

Although interesting, figures do not necessarily tell the true tale as it may well be that much of the recent ore shipped from the district came from dumps and was actually considered waste in the early days of difficult transportation. Today, we often ship dumps at a small profit and the value of this ore does not indicate a decided change in the tenor of the ore bodies underground.

Geology. The Morey workings are all in porphyritic quartz-latite. The nearest sedimentaries exposed, which underlie the quartz-latite, are about one-half mile southerly at approximately 500 feet lower elevation. The country rock here has often been casually referred to as a granite, probably because of its porphyritic texture and high quartz content. As found near the mine the rock is usually highly altered and sometimes contains pyrite. Two veins, the Cedar and the Magnolia, are of principal importance here; they are essentially parallel, the Cedar being about 400 feet north of the Magnolia. Their general trend is westerly with greatly varying dips to the south. Other veins mentioned in the area are very apt to be sections of these two. An important vein having much production and known as the American Eagle may well be the Cedar. Much faulting is noted in the workings and although usually not severe, adds to the difficulty and expense of mining. The ore in the immediate district is usually narrow but often high grade; it is said that when breaking 3 feet the ore will drop to $15 to $20 per ton.

Earl V. Shannon[78] described a sample of the Morey ore which was exhibited at the Centennial Exposition of 1876. He states that the apparent mineralization was first rhodocrosite with fine pyrite, then brecciation, then quartz and silver minerals which partly replaced the carbonate, and then sphalarite which replaced quartz. He describes the specimen as containing a few rare grains of pyrargyrite and stephanite; however, the principal original mineral is andorite, a lead, silver, antimony sulfide which assumes a yellowish tarnish upon exposure. The sample described by Shannon is apparently characteristic of the ore, as

[78]Proceedings U. S. Natural Museum, Vol. 60, art. 16, 1922.

specimens examined on the property generally fit his descriptio very well. The author does not claim the ability to recognize th uncommon mineral andorite, particularly in partly oxidize samples.

Properties. The Morey workings are all on patented claim having various owners. Four patents are owned by Madiso Locke, four patented lodes and two mill sites are owned by V. J and E. S. Barndt, and two patents are owned by the Horace Cam bell estate.

The lowest adit is the Kaiser Tunnel which is connected wit all other adits by an "air shaft," which is actually a raise. It i reported that a company went to considerable expense in 1933 t clean out the Kaiser Tunnel; however, what other explorator work they did is not known. This adit follows the Cedar vein an then swings north to the Magnolia which it follows for a unknown distance. A shaft connects with the cross-cut portio of the adit. It is believed that although there has been som sloughing, much of the adit is open.

Above the Kaiser Tunnel are two adits known as the Upp and Lower Magnolia; the upper adit is about 60 feet above th lower and has much stoping in its 600-foot length. The lower ad has several thousand feet of workings and has been used as a access adit in the more recent work in this particular part of th mine.

In addition to the workings mentioned, there are several othe minor shafts and many stopes open to the surface which may o may not connect with the other openings. V. J. Barndt of Ty has considerable data on the property which includes an old ma of the Morey workings.

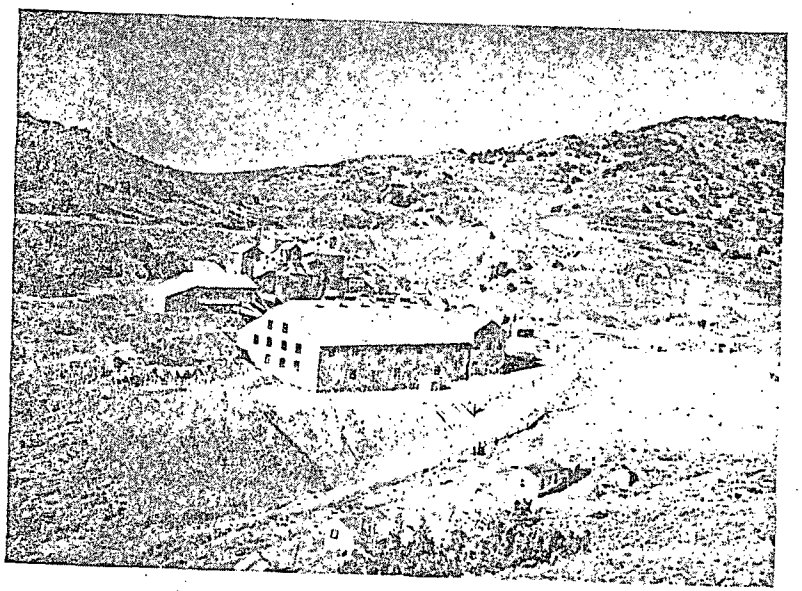
The Walter De Lonais property consists of four patented claim and lies just south of the Morey workings. The area is simila in character, although where noted the vein was more narro Two adits and two shafts on this property total about 600 feet work and are on two parallel veins 300 feet apart. Lessees work this property during 1939–1941, but no report of production h been noted. It is reported that the ore shoots will assay $50 p ton across 18 inches.

The Lead Pipe property owned by H. H. Cowan and Tony No is northwest of Morey and is reached by traveling west over miles of desert road from Moore's Station. Lead ore reported occurs here in the bedding planes of limestone and lime-sha which dip about 10° NW. The mineralized width is usually 1 feet wide. The sedimentaries contact quartz latite about 1,0

feet south of the workings. The property has three short adits on as many levels and it is reported that a little high-grade lead ore was shipped from the lower of these during the first world war.

NORTHUMBERLAND

The Northumberland mining district includes that part of the Toquima Range in the vicinity of Northumberland Canyon on the east side of the range. The principal activity has been near the crest of the range at the head of the canyon. The district is 25 miles north of Belmont and 76 miles by road northeast of Tonopah. Of this distance, 19 miles is pavement and the balance is



(13) Northumberland mill and open pit workings.
(J. C. Perkins)

county road in good condition. Water for both domestic and milling use is abundant in the area.

Thompson and West state that the district was discovered in 1866 by a prospector named Logan. The town was started in 1879 and by 1881 was deserted. They state that a 10-stamp mill was built in 1879, but only operated 3 months. The Monitor and Blue Bell were the principal mines at that time. Activity at the silver mines was intermittent until about 1891, when it apparently ceased. Gold was discovered in 1936 and by 1939 the Northumberland Mining Company began production. This company continued operations until the latter part of 1942.

Early day production was silver, while that of the Northumberland mine was nearly all gold. Couch shows the early day recorded production as $35,778 from 564 tons during 1866–1891. The Northumberland Mining Company produced $1,146,475 from 220,284 tons during 1939–1942.

Geology. J. C. Perkins, in a report on the Northumberland mine, describes the area as largely calcareous and carbonaceous shale underlain by dolomitic limestone and intruded by monzonite and later by a porphyritic rhyolite or quartz latite. The rhyolite may be genetically associated with the ore. The gold mineralization occurred largely in the carbonaceous bed which is 60–70 feet thick. The underlying dolomitic limestone is at least 200 feet thick.

The mineralized area is usually along the margin of what appears to be the roof region of the monzonite whose exposure is about ½ by 1½ miles in size. Much of the shale is highly silicified near the monzonite and often has the general appearance of a quartzite. The monzonite intrusive is very irregular, its exposed contact being a wandering line on the surface. Drilling indicates the intrusive to be much larger at depth.

The ores mined in the past have been from the oxidized parts of both the gold and the silver occurrences. At the Northumberland mine the gold is associated with a small amount of arsenic. In the sulfide zone the arsenic content is only about 0.2 percent; however, it interferes with the cyanidation of the ore. Gold cannot be panned from the Northumberland mine ores.

Properties. The Northumberland Mining Company's property,[79] in the charge of J. C. Perkins of Tonopah, lies at an altitude of about 8,600 feet on the east side of the crest of the Toquima Range. After the discovery of low-grade gold ore here in 1936, the company acquired the ground in 1938 and did extensive churn drill exploration. In 1939 the Weepah mill, with additions including a 900 horsepower diesel-electric plant, was moved to the new property and the operation started in November of the same year. The mill is on the property and is in excellent condition. Its present capacity is 300–325 tons per day.

All mining has been by power shovel in open pits within an area about 400 feet wide by 1,300 feet long. Only sections of this have been removed, assay walls controlling the mining. All ore reserve estimates are the results of churn drilling. A total of 214

[79]Data on this property and the operation was kindly furnished by J. C. Perkins.

holes having an average depth of 88.9 feet were drilled. When in the ore body, the drilling was done on 50-foot centers and holes were bailed for samples every 2 feet. Blocked ore reserves are in two bodies, and exploratory churn drilling found a third just before the mine shut down. This third ore body requires more drilling to establish its limits; however, there is an estimated 30,000 tons of $5.64 ore blocked out.

The mill was planned and built to grind 280 to 300 tons per day, but the ore was harder than expected and only 200 tons per day could be handled. Finally, by adding more crushing and grinding, three stage crushing and two stage grinding, the mill was able to grind 300–325 tons per day. These additions were not completed until June 1941. For a few months the mill and cyanide plant handled 9,000 to 10,000 tons per month, then material shortages hampered the operation. The average milling rate from June 1941 to October 1942, when Government Order L-208 shut the mine down, was 8,600 tons per month. Extraction on the oxidized ore of the upper pit was 78–84 percent; however, during the latter period of the operation, at the lower pit, much arsenical ore was milled and the recovery dropped to about 60 percent.

Future operation will require roasting prior to cyanidation. Metallurgical tests made on the ore indicate that a 700–800° C roast for a maximum of 15 minutes is necessary on the arsenical ore. The roasted ore then gives a 90–94 percent recovery by cyanidation.

The Northumberland mine is equipped with a complete camp, general office, assay office, shops, and other buildings that are necessary for an operation of this size. All buildings are maintained in very good condition.

The Blue Bell, which is one of the old silver mines in the area, is owned by the Northumberland Mining Company. An old chlorination mill, down the canyon on the west side of the range at the edge of Smoky Valley, is said to have handled the ore from here in about 1870 or 1880. There are reported to be about 4,000 feet of workings in the mine, but they are now inaccessible.

The Last Chance group of unpatented claims, owned by Mrs. Essie Scuffe Borrego and Chester and Alice Perrine of Round Mountain, cover old silver workings adjoining the Northumberland mine on the west and lie just below the crest of the range. Two silver veins here cut both the monzonite and schist in the vicinity of the contact. The ore widths are 12 to 40 inches and

sampling shows values of 5 to 40 ounces silver per ton. In most parts of the workings the gold values vary from $1 to $3 per ton; however, one isolated area is said to have a $28 gold value across a 40-inch vein which is opened for 400 feet of length. Three adits, with a total of 1,600 feet of workings, are the principal openings on the property.

OAK SPRING

The Oak Spring mining district lies near the base of the southeast part of the Belted Range in the vicinity of Oak Spring and south of Oak Spring Butte. The district is 115 miles northeast of Las Vegas and is completely within the Tonopah Bombing and Gunnery Range. It is 58 miles north by dirt road from a point on the Tonopah-Las Vegas highway 57 miles northeast of Las Vegas.

As there are no other recognized mining districts for some distance from Oak Spring, it will be necessary to describe some minor properties under this heading that are a considerable distance from the vicinity of Oak Spring.

Several springs in the vicinity supply enough water for domestic use; however, milling water would have to be obtained from a well. During exploration work, done by the Goldfield Consolidated Mines Company in 1938, four holes were drilled in various scattered spots within about 7 miles of the main part of the district. Water was found in only one, which lies 7 miles east of the central area. This is an 8-inch cased well, 350 feet deep, in which water was encountered at 291 feet. A 15 to 20 gallon per minute pumping test lasted for 55 hours then the pump broke down. A pipe line from the well to the mining properties must pass over a ridge 860 feet above the elevation of the well.

S. H. Ball reports that several prospects were being developed in the district in 1905. The activity at that time was for gold and silver, and some chrysocolla of gem quality was sold as turquoise. Lincoln states that some copper ore was shipped in 1917. In late years, the district activity has been almost completely on the occurrences of tungsten as scheelite which was apparently discovered by V. A. Tamney in 1937. Except for minor gold, silver, copper, and gemstone shipments that may have been made in the early days, about $6,000 of tungsten concentrates produced in a dry concentrator in 1940 is the only production made from the district.

Geology. The area is made up of limestone intruded by granite and partly covered with Tertiary volcanics. Ball states, "A

stock of granite, approximately three-fourths of a mile in diameter, cuts the Pennsylvanian limestone 2½ miles south of Oak Spring and sends many apophyses into it. The granite forming a dome, set with many exposures in block-like masses, rises above the near-lying limestone."

The tungsten mineralization concentrated in certain beds and along apparent fracture zones in the limestone. Although the scheelite occurs near the granite intrusive only minor occurrences are found directly on the contact. The area is characterized by huge outcrops of garnetite, or tactite, which usually contain little or no scheelite. The ore contains much garnet and other associated contact-metamorphic minerals; however, greater amounts of garnet are found in wide beds almost completely altered to the mineral.

Properties. The Tamney tungsten property, located by V. A. Tamney in 1937 as the Climax group and believed to be presently owned by the Pacific Bridge Company of San Francisco, is centrally situated in the district. The Goldfield Consolidated Mines Company did considerable exploration here in 1938 and again in 1940. In 1939 the U. S. Vanadium Corporation spent a reported $11,000 doing a very complete sampling job. In 1941, after these companies had relinquished their option and the price of tungsten continued to rise, the present owner became interested in the claims. Except for 15 tons of ore, treated in a local dry concentrating mill for sampling purposes, no production has been made from the claims.

Of four or five ore showings on the property, one is on the granite-limestone contact and the others are apparent bed replacements usually in the hanging wall of the wide, prominent garnet zones. Two or three of these occurrences are indicated to be of size and grade of definite interest as potential ore reserves.

Sampling by the U. S. Vanadium Corporation indicated one ore body of 175-foot length having 1.08 percent tungstic trioxide for a width of 7.3 feet; another body in three parts is indicated to have a total of about 270 tons per foot of depth containing 0.53 percent tungstic trioxide; another smaller area is calculated to have about 1,000 tons to a depth of 25 to 30 feet containing 1.60 percent tungstic trioxide.

Exploration by the Goldfield Consolidated Mines Company consists of an adit with 950 feet of workings driven 315 feet below one of the better outcrops. The adit did not encounter the ore body and it is reported that the workings are still short of the dip

projection of the ore. In addition, the company drove two shorter adits on other exposures. In 1941 the Pacific Bridge Company built more roads on the claims preparatory to driving another adit but work did not begin as the area was closed by government order establishing the Tonopah Bombing and Gunnery Range.

The only improvement on the ground is a large stone cabin in fair condition.

The Indian Trail group, lying southwest of the Tamney group, is owned by Owen R. Speirs and others. During the latter part of 1940 it is reported that 110 tons of ore from here, containing 0.94 percent tungstic trioxide, was milled at a dry concentrator in the district. Concentrates recovered were valued at $1,150 which is the only known production made from the property. The workings include a shallow inclined shaft opened into an open pit by the last mining operation.

The Crystal claims, owned by the estate of Albert Ninnis and others, lie about a mile southwest of the Tamney ground. It is reported that several hundred tons of ore from here was milled in the dry concentrator; however, the tungsten content of the ore is not known. The scheelite occurs in shear zones in the limestone and is more of a vein type deposit than the occurrences on the Tamney ground. Some relatively high grade, although sporadic, samples were found. The workings include a 30-foot shaft with 20 feet of laterals, a 70-foot shaft connecting with a 150-foot adit, and much trenching. Ore has been taken from the trenches and from a stope between the adit level and surface. Some of the workings on this group are the result of early activity on gold ores in the district.

The Garnetyte Lode claim, owned by Wesley Koyen and Dean P. Thiriot, adjoins the Tamney group on the southeast. In 1940, I. F. Smith leased this claim and milled 2,500 tons of ore in the dry concentrator he built on an adjoining mill site. Tungsten concentrate valued at $4,000 was produced. As it is known that the mill made a poor recovery, the ore is not as low grade as it appears. The principal work on the property is a large open cut in a hard garnetite bed from which the ore was mined. The Smith mill was removed shortly before World War II.

The Michigan Boy group, owned by Ed Lane of Groom, Lincoln County, lies about 6 miles southeast of the central portion of the Oak Spring district. Partly oxidized argentiferous galena occurs in a vein in flatly lying calcareous shale. As exposed in surface workings, the vein can be traced for several hundred feet; it is 8 to 24 inches wide, strikes southwest, and dips about 65° SE.

The workings consist of a 50-foot inclined shaft, several shallow shafts and holes, and a few trenches. Ore piled on the dumps of the larger openings contains 11 to 16 ounces silver per ton and 1½ percent lead.

The Rainstorm group, owned by F. A. Monson of Las Vegas, lies 10 miles southeast of the Oak Spring district proper and about 15 miles southwest of the Kelley mine in the Groom district. The property is reported to contain lead, silver, and gold ore; 50 tons of which was shipped prior to World War II and said to contain 55 percent lead, 25 ounces silver, and 0.25 ounces gold per ton. Two samples of the vein, taken by an examining engineer, averaged 31.5 percent lead, 0.07 ounces gold, and 11.6 ounces silver per ton. Workings are said to consist of a 220-foot shaft, a 150-foot adit, and several shallow shafts and cuts.

The Old Glory patented claim, owned by Arnold R. Burr and others, is situated 10 miles southwest of the Oak Spring district proper and 3½ miles southwest of White Rock Spring. It is sometimes erroneously considered in the Kawich district which is 27 air line miles northwest. The claim was patented in about 1927 and it appears that the last work was done about that time. A completely caved near-surface adit and shallow shaft were driven on shears in a highly altered calcareous shale. Samples of the mineralized zone indicate a low silver content.

A deposit of "bone" magnesite occurs in limestone near beds of chert, 14 miles north of U. S. Highway No. 95 and 2 miles northeast of the Oak Spring road. The deposit is largely low grade; however, some sorted magnesite ore contains 43.6 percent MgO, 2.1 percent SiO_2, and 3.4 percent CaO. Ownership of the claims is not known. This deposit is also inside the Tonopah Bombing and Gunnery Range.

REVEILLE

The Reveille district is in the northern part of the Reveille Range and includes the area on both sides of the range, but does not include the northern tip of the Reveille Range which is known as the Arrowhead mining district.

The district has two principal camps, Old Reveille and New Reveille. The former is 2 miles or less air line northeast of the latter, and the road distance is 10 miles. The southern camp is on the west side of the range, near its crest, and the northern camp is well down on the east side of the range. New Reveille is reached from Reveille Valley and is 25 miles southeast of Warm Springs on the Tonopah-Ely highway and 74 miles from Tonopah. Old Reveille is 21 miles by road from

Twin Springs and Railroad Valley. The roads to the properties on the west side of the range, where most of the activity has been, are generally in good condition. The roads on the east side, however, are poor and the sandy condition of the washes often makes them nearly impassable during the dry season.

Lincoln states that the district was discovered in 1866 by Indian Jim. He showed it to white men who organized the district and named it in honor of the Reese River Reveille of Austin. He states:

> In 1867, a 5-stamp mill was erected west of the mines, and in 1869 a 10-stamp mill, but they only operated a short time. In 1875, the Gila Silver Mining Company acquired the principal properties and reconstructed the 10-stamp mill, which ran intermittently for 4 years. The camp was abandoned in 1880. In 1904, interest in the district revived and an irregular production has been kept up since.

Couch shows a recorded district production of $610,982 from 8,261 tons during 1866 to 1920, and O. J. Belleville produced $2,089 from tailings in 1946.

The mill Lincoln mentions was built in Reveille Valley 10 miles west of the western part of the district and is one of the principal landmarks in the area. The mill has been rebuilt several times, the last addition being made by O. J. Belleville in 1945.

Mineral Resources shows an intermittent production since 1911; however, much of this has not been recorded. Most of the ore has come from New Reveille, principally a lead camp. Production from here has been as recent as 1948.

Geology. The principal rocks in the area are Paleozoic limestone and quartzite with the latter the older. The sediments are covered by Tertiary rhyolite in much of the area, particularly near Old Reveille. Here the ore is found near the contact of the rhyolite with the quartzite. The ore occurs in quartzite at both Old and New Reveille. The several properties on the west side of the district and north of New Reveille are in limestone. Latite and rhyolite porphyry dikes are common in the area and it may be assumed that they are genetically related to the ore deposits.[80]

The ore minerals are cerargyrite and cerussite in the near surface ores, with the sulfides increasing with depth. Some antimony minerals are associated with the silver ores of Old Reveille

[80]Spurr, J. E., Nevada South of the 40th Parallel and Adjacent Portions of California: U. S. Geol. Survey Bull. 208, p. 163, 1903.

and a stibnite deposit occurs about one-half mile east of the Gila silver mine. At New Reveille the surface ore is largely cerussite and cerargyrite with argentiferous galena at depth.

Properties. The Gila mine at Old Reveille, consisting of one patented claim owned by V. J. Barndt of Tybo, has probably been the largest producer in the district. It appears that nearly all production was during 1866–1891 and that the ore averaged $87 per ton, principally in silver. Couch shows over half a million dollars production. The old workings consist of a shaft reported[81] to be 460 feet deep, two long adits, and several shallow holes. Most of the work has been done in quartzite near its contact with the younger rhyolite. Surface seams in the quartzite must have been extremely rich as shallow workings literally have scalped the surface rock over an appreciable area. The owner reports that no known work has been done here since about 1891.

The Antimonial and Black Hawk groups lie one-half mile east of the Gila. The former is owned by the Homer Buckley estate, and the latter by Mabel E. and E. M. Booth of Tonopah. Stibnite occurs here in seams and bunches in a quartzite bed which is either a faulted segment of the quartzite found at the Gila or is a parallel bed. The ground is explored by two adits and many open cuts, totaling several hundred feet of work. A small shaft furnace and condensing system installed here was reportedly used during World War II to produce antimony trioxide directly from the ore. It is believed that very little ore was roasted in the furnace.

The New Reveille lead mine, embracing four patented claims owned by V. J. Barndt, Madison Locke, and Harvey Titus, lies at the south end of the district about 2 miles air line south of Old Reveille. The name New Reveille is a relative term as this property was new in the eighties. Couch shows a recorded production of $25,545 from 197 tons during 1881–1890. Mineral Resources reports an intermittent production since 1911. As per the records of V. J. Barndt, about 1,500 tons of ore containing 10–30 percent lead and 6–20 ounces silver per ton was mined from 1917 to the present. This represents a gross value of about $30,000.

The ore occurs in quartzite contacting rhyolite east of the workings. The ore zone is highly oxidized near the surface and no sulfide minerals were found in the surface ores.

A three compartment shaft with large headframe, and a long adit from near the collar, are the principal workings. The adit

[81]Thompson and West.

is reported to have very large open stopes and its workings connect with those off the shaft. Much work also has been done by lessees in open cuts and shallow shafts.

The Alladin group, owned by Amature and Ethel [illegible] Yerington, is situated about 2 miles north of New Reveille. It is a silver property reported to be prospected by several [illegible] shafts in limestone. The ground was relocated by the present owners in 1934 and they report that lessees shipped [illegible] from here in 1938.

The Kietzke property, owned by Mrs. Lou F. Kietzke of [illegible] California, lies about 3 miles north of New Reveille on the [illegible] side of the range. Extensive work has been done on silver-[illegible] quartz stringers showing some copper occurring in quartz [illegible] and limestone along their contact. The camp has a cabin and [illegible] sheds in fair condition. It appears that no work has been [illegible] on the property for many years.

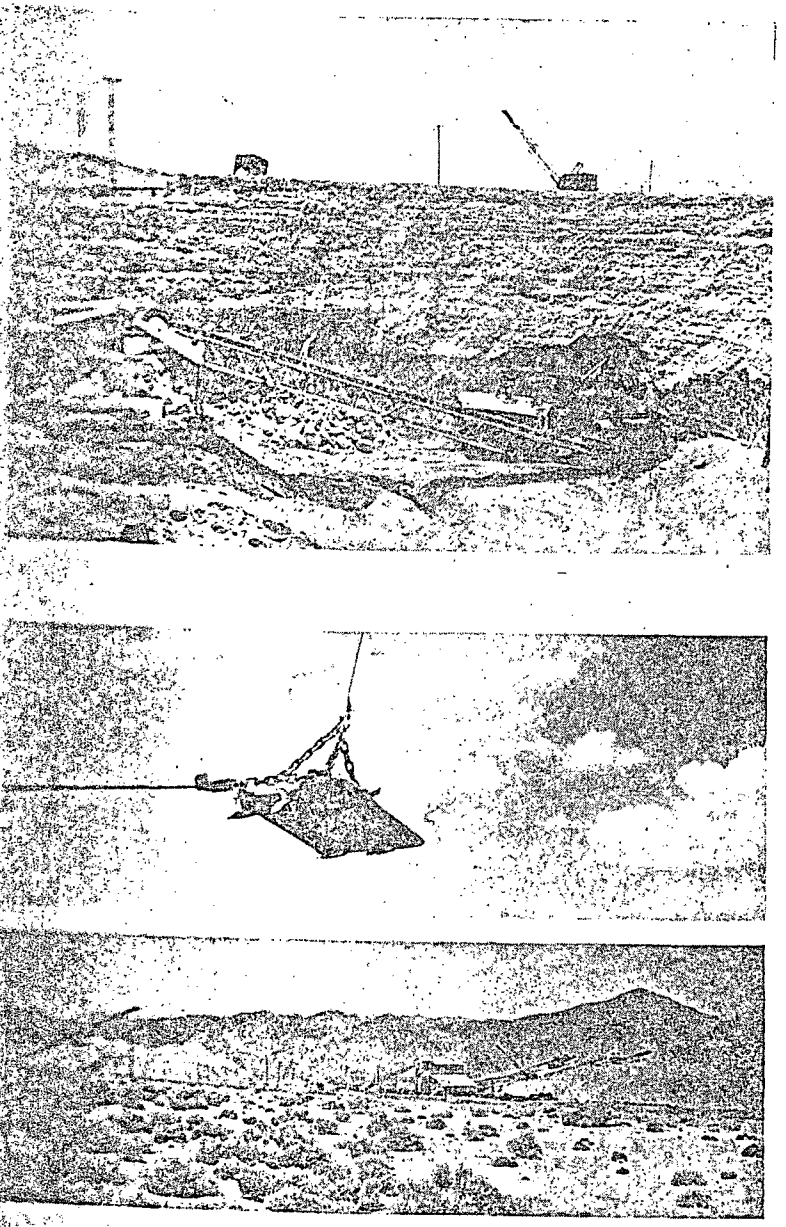
The Stancher property, now of unknown ownership, lies at the north end of the higher elevations of the range, about 1 mile [illegible] line northwest of the Gila mine of Old Reveille. An adit has been driven in a highly altered zone near the contact of the limestone with the quartzite to the east. There is no road to the workings and it is believed that no production has been made from here.

ROUND MOUNTAIN

The Round Mountain mining district lies in the [illegible] symmetrical hill of silicified rhyolite, referred to as Round Mountain, which sits slightly out from the west slope of the Toquima range. The town of Round Mountain is on the north side of the hill and is 57 miles by paved highway north of Tonopah.

Louis D. Gordon of Reno is credited with the discovery of the district in 1906, in the same year Thomas Wilson discovered the presence of placer gold below the lode deposits. Several companies soon started operations here and production from the district began in 1907. This production, from both lode and placer, continued at a fair rate until about 1940 when the Dodge Construction Company ceased its placer operation. The last underground mining was done by the Nevada Porphyry Mines in 1951.

Originally the camp had many operating companies but consolidations and other transactions decreased the [illegible] which in 1929 pooled their resources to form the Nevada [illegible] Gold Mines, Incorporated, with Louis D. Gordon as [illegible]. This company now controls essentially all the lode and [illegible] properties in the immediate area of Round Mountain.



Operation of the Round Mountain Gold Dredging Corporation.
Upper. Looking down on the mining operation.
Center. The scarifying drag weighs about 7,200 pounds.
Bottom. The washing plant with its huge stockpile on the left and tails on the right.

Water was originally piped from Jefferson and Shoshone Canyons, but, it is now obtained from Jett Creek across the Big Smoky Valley to the west. Recently this supply has been supplemented by two wells drilled in the valley. Power is purchased from the California Electric Power Company that transmits it from Bishop, California.

As per figures kindly furnished by Mr. Gordon, a gross production of $6,625,000 was made by the Round Mountain mines to August 15, 1933. Recorded gross production after that date, as given by Couch, is about $1,225,000 from the Nevada Porphyry Mines. This would make a total from the district of $7,850,000 to the end of 1940. The only appreciable production since then is that now being made by the Round Mountain Gold Dredging Corporation which started operation on January 1, 1950.

Of the nearly 8 million dollars produced from this group of mines, one and one-half millions have come from placers. Considering the present operation, it may be expected that in a few years the placer production will have overshadowed the total lode production. The average yield of all placer operations in the area is believed to have been almost $1 per cubic yard.[82]

The Gold Hill mine, which lies a few miles north of Round Mountain, has not been included. Data kindly submitted by Mr. Albert Silver show a total production of $987,000 from this property during 1930–1942. With this amount, the Round Mountain mining district has a total production of nearly 9 million dollars.

Geology. H. G. Ferguson's report[83] well describes the area geology of the district. Excerpts from his report follow:

> The rocks in the neighborhood of the Round Mountain consist of Paleozoic sediments, granitic rocks of probable Mesozoic age, and later Tertiary igneous rocks and lake beds.
>
> The Paleozoic rocks are for the most part dark limestones, which are interbedded with black jaspar, and dark slaty schist, chiefly of Ordovician age. Ordovician fossils (graptolites) were found on the ridge north of Mariposa Creek, about 4 miles south of Round Mountain, and the underlying rocks in this locality closely resemble the series of Ordovician sediments of the Manhattan district. Sedimentary rocks, consisting chiefly of schist

[82]Vanderburg, William O., Placer Mining in Nevada: Univ. of Nev. Bull. Vol. XXX, No. 4, p. 133, 1936.

[83]Ferguson, H. G., The Round Mountain District, Nevada: U. S. Geol. Survey Bull. 725–I, pp. 386, 397, 1921.

and thin beds of crystalline limestone occur in the valley of Jefferson Creek, about 4 miles northeast of Round Mountain.

The ore deposits of the Round Mountain district belong to two periods. The earlier of these periods followed the granite intrusion and is characterized by tungsten ores. To the later period belong the gold-bearing veins of late Tertiary age.

In the Round Mountain district the ores formed as a result of the granite intrusion are represented by small veins in the granite that carry small quantities of the manganese tungstate huebnerite. These veins have been known since 1907, but the early attempts to develop them were unsucecssful. In 1915 a small quantity of tungsten ore was produced by working residual surface material with dry-washing machines.

Mineralogically the veins are comparatively simple. Huebnerite is the only metallic mineral present, except in a few veins close to the slate contact, where a little tetrahedrite also occurs. The quartz is coarsely crystalline, with rather rare vugs. The sharp heubnerite crystals inclosed in the quartz suggest that the crystallization of these minerals was simultaneous or that the quartz was slightly later. Muscovite is present in nearly all the veins but is usually confined to a narrow band close to the walls. Fluorite, in complex delicate pink crystals, was seen in nearly all the veins, usually as crystals on the faces of projecting quartz pyramids in the vugs and more rarely as poorly defined streaks in the central parts of the veins. A very slight amount of oxidation is shown by minute amounts of manganese oxide stain and small specks of yellow tungstite. Concentrates from these deposits, from the old mill on Shoshone Creek, showed, aside from a little magnetite derived from the granite, only huebnerite and fluorite.

The profitable gold deposits are confined to the rhyolite on Round Mountain and the neighboring hill to the east. The hills south of Round Mountain consist of similar rock but appear to be barren.

The principal veins on Round Mountain are known as the Los Gazabo and the Keane. The Los Gazabo crops out on the south flank of Round Mountain. It strikes

westward and dips about 15° N. It has yielded ore for 900 feet down the dip, or less than 350 feet vertically below the outcrop. The Keane vein dips to the south and has proved productive only in the lower levels. The Mariposa vein lies north of the Keane and dips gently to the south. Several rich stringers have been encountered at depth on the footwall side of the Los Gazabo. In the so-called sheeted zone, on the west side of the hill, and the stringer section east of the shaft small veinlets occur so close together that the entire deposit has been mined by the glory-hole method.

The grade of ore mined differs according to the method of mining adopted. From 1910 to 1917, when the Round Mountain Co. for the most part mined its own ores, a large tonnage could be handled economically, and the average value of bullion recovered per ton of ore was between $6 and $7. In 1918 and 1919 the leasing system was chiefly used, and small rich streaks were followed by the lessees. During this period the average value of bullion recovered per ton of ore mined was $35.77. In 1920 the recovered value per ton of ore mined on company account was $4.73 and that mined by lessees $52.68.

The range of ore deposition is comparatively shallow. The deepest ore mined, from the 900-foot level of the Sunnyside mine (about 300 feet below the collar of the shaft), is above the water level and about 700 feet below the top of Round Mountain. Elsewhere in the district the productive zone appears to be even shallower.

Free gold is the only valuable mineral obtained, for although auriferous pyrite is present in some veins the quantity is too small to warrant concentration or cyanidation. The gold is intercrystallized with quartz or associated with limonite and minor manganese oxide in small fissures in which quartz may be lacking, and both types of occurrence may be present in the same vein.

The primary quartz veins are for the most part not continuous over long distances. The Keane vein and apparently also the primary veins of the Fairview seem to have followed pre-existing faults. These veins generally do not exceed a few inches in width, and much of the high-grade ore from the top of Round Mountain came from veins scarcely over an inch wide.

The primary metallic minerals present are gold, pyrite, and rarely realgar. The gangue consists essentially of quartz together with accessory adularia and alunite and rarely fluorite.

After the primary quartz veins were deposited, new fissures were formed. This later fissuring was probably as extensive as the original fissuring, but for the most part the later fissures did not follow closely the original veins. The supergene waters that oxidized the auriferous pyrite in general followed the new channels, which crossed the older veins at many points, and iron oxide and secondary gold were deposited along these newly formed fissures.

The result is a second type of vein which consists of a fissure filled chiefly with mixed oxides or iron and manganese, the iron in excess of the manganese. Commonly the adjoining country rock is shattered for some distance from the major fissure, and in many places the smaller parallel fissures are the more productive. Crushed fragments of vein quartz occur here and there, but in some of these fissures no gangue minerals other than limonite and pyrolusite are present. The gold is usually inclosed in limonite or manganese oxide, in the middle of the fissure. The gold in these veins differs from that of the quartz veins in that distinct individual crystals are absent, and it occurs in small thin plates or delicate flat feathery crystals, that never show the greenish tinge commonly seen in the gold from quartz veins.

The veins of Round Mountain and the neighboring hill to the southeast have yielded placers, which are in places exceedingly rich. Most of the placer production has come from the immediate vicinity of Round Mountain, but placers have also been mined in the low ground south of the ridge between the Fairview and Sunnyside mines.

In the early days of the camp good returns were obtained from surface material on the slopes of Round Mountain worked by dry-washing machines. Water, however, was soon brought from Jefferson and Shoshone creeks and hydraulic mining commenced. This supply was insufficient, and in 1915 the Round Mountain Co. completed the installation of a 9-mile pipe line to bring

water from Jett Canyon, in the Toyabe Range. Even this pipe line did not supply sufficient water for hydraulic operations throughout the year, and the length of the mining season varies with the amount of winter snowfall in the mountains. Under ordinary circumstances placer operations can not be continued later than July.

The placer gravel at the Sunnyside mine is composed of coarse, angular rhyolitic wash, without definite bedding. Where it is being mined near the hill the maximum depth is about 30 feet, but it deepens toward the valley. Out into the valley, however, the angular rhyolitic talus is covered by roughly stratified material containing an admixture of granite pebbles and boulders unsorted in size. This material carries far less gold than the angular unstratified rhyolitic material beneath it.

The grade of bedrock toward the valley is about 4 percent and that of the surface is somewhat less, so that the deposits become thicker to the west. Some shafts sunk in the valley west of Round Mountain to depths of 100 to 200 feet indicate the possibility of old stream channels along bedrock, which may prove profitable. These channels were presumably formed during an earlier, more humid period of permanent streams.

Although the gold is found in workable amount throughout the unsorted material, in places the material that rests directly on bedrock is extraordinarily rich. The writer has seen six small egg pans of gravel taken just above bedrock that yielded 0.4 ounce of gold.

The gold is angular and coarse and shows no evidence of any transportation. Nearly all the nuggets carry particles of either quartz or siliceous limonite attached to their surfaces. Besides the gold, the concentrates contain only a little finely divided magnetite and small grains of limonite and manganese oxide. As far as appears from the inspection of a few nuggets, the two types of gold—that of the quartz veins and that which occurs in the limonite fissures—are about equally represented.

On the Red Top claim in the wash to the east the rhyolitic material is to some extent contaminated with granite wash, and a little huebnerite and monazite, together with rare specks of native copper, were found.

The angular material of the Round Mountain placers, particularly that near bedrock, is in places cemented by a limy deposit into a hard conglomerate. In places small cavities between the pebbles have been filled with crystalline calcite. The gradual break-up of this hardpan in the sluice boxes prevents any marked concentration of gold in the upper boxes.

Properties. The Nevada Porphyry Gold Mines[84] property includes essentially all the gold mines in the immediate area of Round Mountain. The Los Gazabos shaft, the principal working, is 1,200 feet on a 20 degree incline and has about 10 miles of workings. In addition to this there are the Gordon shaft, Placer Vein shaft, No. 2 shaft, and Fairview shaft, all between 250 feet and 350 feet in depth; and three main adits. Other workings are more shallow. A 240-foot vertical shaft sunk in the alluvium by the Nevada Gold Development Company encountered 210 feet of pay gravel.

Several attempts have been made to develop a large low-grade gold deposit. During 1931–1933 the Nevada Porphyry Gold Mines spent about $105,000 in sampling and exploration, which resulted in blocking out 13 million tons of reasonably assured ore of $1.50 per ton value, at that time. The increase in the price of gold in 1934 would make the present value $2.60 per ton. The company milled about 6,000 tons taken from the better part of this ore and recovered $2.53 per ton. At the same time the company blocked out a million yards of gravel of $1 per yard value. After several other groups spent about $150,000 sampling the placer, the last being the present operating company, about 42 million cubic yards of gravel, estimated to contain 30 cents per cubic yard, had been developed. During 1935–1936 the A. O. Smith Company spent a reported $916,000 exploring and sampling lode deposits of the Round Mountain and Manhattan districts in an attempt to develop a large low-grade deposit. It is understood that they abandoned their work as they could not come to an agreement of terms with the Nevada Porphyry Mines, on whose ground most of the work was done. Their sampling was characterized by huge samples and an excellent assay office operated 24 hours per day. It is said that 12 assayers were employed on each shift, and fusions were run in large crucibles using 5 assay tons each.

The Round Mountain Gold Dredging Corporation, controlled

[84]Data on the property kindly furnished by Mr. Louis D. Gordon.

by the Consolidated Gold Fields of South Africa, Ltd. and the Yuba Consolidated Gold Fields, now has a lease on the Nevada Porphyry Gold Mines property. The company became interested in the ground in 1945 and after doing considerable sampling, in addition to that done by prior groups, decided to install a washing plant. The plant was installed by the Yuba Manufacturing Company in 1949 and the operation started about January 1, 1950. Although the plant has operated since the first of the year, an installation of this type requires considerable time to work out the "bugs," and changes are still being made. The Round Mountain work is being conducted under the guidance of E. H. Oshier, field superintendent; M. W. Meisenheimer, general foreman; and Morton E. Pratt, metallurgist.

The general plan of operation is a combination of road gravel mining technique with dredge type washing and is capable of handling ground that cannot be dredged. That is, gravel that is either too deep and/or will not hold water. Mining here will eventually be in a pit having a maximum depth of 300 feet or more.

The method of mining the gravel is patterned after a plan in use in some road gravel pits. A scarifying drag, weighing about 7,200 pounds, is swung from the boom of a dragline on the bank of the pit and loosens the partly cemented gravel as it drags up and down the steep slope of the pit. A 7½-cubic yard electric shovel digs the toe of the face and picks up the loosened gravel which it dumps into a can-type hopper with 30-inch grizzly. The grizzly lays on top of the can and is merely tilted with a dragline to dump the oversize boulders. From the hopper, a 60-inch conveyor belt moves the gravel to a 42- by 36-inch jaw crusher mounted on a moveable car.

The crusher car, with its 60-inch feed belt, is a unit in which the belt is swung as a pendulum around the crusher. When an arc of the face has been mined, the crusher car and feed belt are moved ahead toward the face to prepare for the mining of the next arc.

The purpose of the crusher in the pit is to remove boulders by reducing to a size for belt transportation. In this way all rocks under 30 inches in size need very little handling and are removed from the pit. Only boulders over 30 inches in size are left behind and their quantity is not believed enough to become a problem.

Material leaving the crusher car is minus 10 inches in size and is transported by 42-inch conveyor belt to the stock pile at the

washing plant. The distance from a transfer point in the belt at the head of the pit to the stock pile is about 2,500 feet.

The use of the drag scraper is one of the most important features of the operation. It simplifies the mining of the partly cemented gravel to one bench only and makes the use of explosives unnecessary. It greatly improves safety conditions in the pit as it reduces to a minimum the loose rocks rolling down the bank. However, as there is no blasting, no men work on the slope or the toe of the face, making the hazard of accident by falling loose rock nearly negligible.

The stock pile is somewhat similar to those used at other well-planned large operations. A cut is completely concreted leaving draw points, in this case two. The gravel is stacked in a huge pile over the draw points and drawn by electrically controlled vibrating feeders to a conveyor belt which places it in the plant.

In the washing plant the gravel goes directly into a ½-inch trommel where it is thoroughly washed and the oversize goes to one or the other of two tails stackers. This is the route by which boulders in the pit are removed; the pit crusher reduces them to a size that can be handled and they are conveyed to the plant, through the trommel, and to tailing disposal.

The trommel undersize is divided by vibrating screens into minus and plus 8 mesh products which are handled separately by Yuba dredge type jigs and Hungarian riffle gold tables with mercury traps. Part of the concentrate is ground in a ball mill before amalgamation. Some of the gold recovered is in the form of electrum.

The washing plant is very similar to a dredge and in capacity is about comparable to a Yuba 18-cubic foot size. Sand wheels are used to elevate and dewater, and conveyer belts are used to facilitate the handling of large tonnages.

The Round Mountain Gold Dredging Corporation plans to eventually handle 17,000 tons per day with a total crew of 50 men. The washing plant operates 24 hours per day and mining is conducted on two shifts. The mine and plant work 6 days per week. On this basis, it is planned that the life of the operation will be 15 years or more.

The Gold Hill mine,[85] situated on a small hill of silicified rhyolite 4½ miles north of Round Mountain, is owned by the estate of Thomas F. Cole. The property was probably discovered shortly after the influx into Round Mountain. In about 1910, two prospectors had a shallow shaft on the vein but had sunk on a "horse"

[85]Information kindly furnished by Mr. Albert Silver.

in a split of the vein. In about 1930 the Tonopah Mining Company and the Tonopah Belmont Development Company purchased the ground and began exploration. A 500-foot shaft was sunk, and mill built, which produced $770,000 from 94,500 tons of ore during 1930–1933. T. F. Cole purchased the property in 1934, but did not operate it before his death in 1938. Since 1934, lessees have produced $217,000.

The ore has come from several parallel and branching veins striking westerly which are said to be traceable for about 930 feet on the surface and for 1,075 feet on the 225-foot level. The ore has a rake to the west and is cut off on this end by faulting. It appears that the property's potentialities lie in finding more ore beyond the faulting on the west or in the development of new bodies in parallel veins.

The present workings include the 500-foot Gold Hill shaft with six levels and the 300-foot Toquima shaft. The 225-foot level of the Gold Hill shaft is the lowest accessible working as water stands below. This shaft is also said to be caved between the 300- and 400-foot levels.

Mr. Silver reports that the mine is fully equipped with useable, although antiquated, machinery, and a cyanide mill on the ground is in rehabilitable condition.

The Rainbow uranium prospect, located by John Henebergh in 1928, lies about 1 mile east of the town of Round Mountain. The mineral autunite was identified in the ore by the Nevada State Analytical Laboratory in 1930. At present the claims are optioned to the Nevada Uranium Products Corporation that is driving exploratory workings. The uranium occurrence appears to follow a 6- to 10-foot kaolinized aplite dike in altered granite. The dike has a northeast strike and dips about 70° SE. It has been traced for 1,300 feet on the surface. In May 1950, a drift adit was 366 feet long and had a 152-foot winze in addition to some cross-cutting. The uranium indication is reported as good in the bottom of the winze as it is in the adit. Some samples of the material assay 0.16 percent uranium oxide.

The Violet Blue uranium prospect, located by Ed Michal and John Henebergh of Round Mountain, is situated just off Shoshone Canyon about 1 mile air line northeast of the Rainbow claims. This property is one of the early tungsten prospects. A 160-foot adit on a shear in granite is said to have been driven in the early 1900's in search of tungsten occurring as huebnerite. The adit shows some autunite and picked samples are said to contain 0.2 percent uranium oxide.

The Steigmeyer property, owned by the estate of Frederick Steigmeyer, is situated 3.5 miles south of Round Mountain. A gold occurrence here in shale has been mined by power shovel from a cut. In May 1950, John M. Ferry of Glendale, California, was attempting to beneficiate the ore by screening at the mine and had planned to mill the fines on Jefferson Creek. Equipment at the mine included a one cubic-yard power shovel, a dozer, and a simple trommel screening plant.

ROYSTON

The Royston district is near the south end of a spur off the Cedar Mountains on the west side of Big Smoky Valley. It is 39 miles by road northwest of Tonopah and of this distance 25 miles is on paved highway. The altitude of the area is about 5,500 feet. The nearest water is believed to be at Crow Spring, about 10 miles southwest in Esmeralda County. The California Electric Company power line to Gabbs passes 3 miles east in the valley below the district.

Royston has been strictly a leasing camp, it being first highly publicized in 1921 by the Foy-Betts Lease, on ground then owned by the Hudson Mining and Milling Company. Lincoln reports that about $20,000 of rich silver ore was mined from a shaft 24 feet deep in 6 weeks time. The first mention of metal mining in the district was noted in Mineral Resources (1917) which states that silver ore mined here was treated at Tonopah and lead ore was being shipped to smelters. Couch shows a recorded production of $26,675 from 218 tons during 1921–1939. Of this amount the Betts Leasing Company produced $21,270 from 60 tons in 1921.

Nevada is one of the principal sources of turquoise in the United States and much of this gem material has come from the Royston district, and the Cloverdale area to the north. One turquoise deposit in the Royston district is now being worked, and it appears that many occurrences of the gem material have been mined in recent years. No information seems to be available on the turquoise production of the district, but there is little doubt that it at least equals and probably surpasses the metal production. Tiffany Company reportedly mined turquoise here during 1905–1912 and it is quite likely that the Indians mined the material long before the white man.

Geology. The Royston hills, as the area may be described, are at the extreme southeastern edge of a plateau joining the Cedar

Mountains to the northwest. This plateau is 500 feet above Big Smoky Valley.

Flatly lying chert conformably overlain by quartzite is the principal rock in the district. Highly altered andesite dikes are very common in the area. Ferguson and Muller[86] indicate the sediments to be of the Triassic Excelsior formation which also includes volcanics. It may be that at least some of the andesite noted as intrusive, actually is a Triassic volcanic in fault contact with the sediments.

The silver and lead mineralization occurred in the cherts and is found at the lower elevations of the district. The highest-grade ore came from relatively near the surface and is assumed to have been largely oxidized.

Turquoise is found in the chert at its contact with the overlying quartzite, and numerous shallow diggings outline the flatly lying contact. As is characteristic with the mineral, the turquoise is found in narrow seams and the occurrence of the better-grade material is extremely sporadic.

Properties. The Royston Coalition Mining Company of Salt Lake City owns six patented and several unpatented claims that cover the silver-lead occurrences. The Foy-Betts inclined shaft and adit are on the north side of the canyon, approximately across from the 300-foot Campbell and Kelly inclined shaft and adits on the south side of the canyon. A 225-foot vertical shaft just south is known as the Walker shaft; the workings connect with the Campbell and Kelly. Although it is reported that the vein in the Walker shaft does not continue into the Campbell and Kelly, a north bearing shear associated with the ore appears to connect the three major groups of workings. The last work in the camp was done at the Walker shaft; Gene Perry of Mina, and Jim Lied of Tonopah, having leased here during 1948.

Most of the workings are in chert; however, considerable andesite has also been encountered. It is reported that the laterals off the Walker shaft are largely in andesite and that although galena is common in the ore, much of the mineral carries only a little silver.

The Royal Blue and other unpatented turquoise claims are owned by Lee Hand of Tonopah and Battle Mountain. It is believed that Earl Mayfield and others of Tonopah have a lease on part of the ground at the present time. Although minor turquoise workings are scattered all over the area, the diggings on

[86]Op. cit: U. S. Geol. Survey Prof. Paper 216, plate 1.

this group appear to be of greatest importance. The property is at the higher elevations of the district, slightly above the plateau to the northwest.

In addition to several shallow shafts and short adits, a glory hole of about 400 square feet size with adit is the principal turquoise working here. Recent mining has been done in one of the short adits. Improvements consist of a house in good condition and two small sheds.

SAN ANTONE (Cimarron, Liberty, San Antonio)

The San Antone district covers the northern part of the San Antonio Mountains and adjoins the Tonopah district on the north. It includes the camps of Liberty and Cimarron, respectively, 23 and 31 miles by road north of Tonopah. Cimarron, at the north end of the range, is at an altitude of 7,000 feet and the mining properties along the west face of the mountains are at about 6,000 feet elevation. Water is obtained from small springs near the mines. Roads in the area are all unimproved and in fair condition.

In the past the San Antone district has included the Royston area, which is on a spur of the Cedar Mountains west across the Big Smoky Valley from the San Antonio Mountains. As the miners and prospectors refer to Royston as a mining district, and as it is in an entirely separate range, it is described individually elsewhere in this publication.

Thompson and West state that the San Antone district was discovered in 1863 by a party of Mexicans and organized the next year. In 1865 a 10-stamp mill was built at San Antonio station, but it was removed a year later, and in 1867 replaced with a 4-stamp mill which ran for a short time only.

Joe Clifford[87] of Stone Cabin reports evidence that old diggings 1.5 miles southeast of Liberty were worked in 1854 by Mexicans.

Couch reports a recorded district production of $116,301 from 923 tons during 1867–1888. Small intermittent production made since the turn of the century would probably increase this total considerably, however, this production was not recorded.

Geology. The areal geology is somewhat similar to the Jett district in the Toiyabe Range to the north. Cherts, slates, and limestones believed to be Ordovician are covered by Permian volcanics[88] which in turn are covered with Tertiary volcanics, usually rhyolites and latites. A few fine-grained dikes were noted

[87]Personal interview.

[88]Op. cit.: U. S. Geol. Survey Prof. Paper 216, plate 1.

in the area, and at the north end of the Liberty an alaskite stock intrudes a mica schist and quartzite unconformably overlain by limestone.

At the Liberty mine, which has been the principal producer, a silver and gold ore occurs in Permian volcanics. Partly oxidized argentiferous galena, oxidized silver minerals, and partly oxidized copper minerals occur in Ordovician limestone at the Florence mine 3 miles northeast of Liberty. Manganese is found in shear zones in rhyolite south of Liberty. Gold ore is found in stringers and bunches in Tertiary rhyolite and Permian andesite at Cimarron.

An occurrence of molybdenum as molybdenite and its oxidation products is of interest as a potential future source of the metal. This property is just north of the old camp of Liberty.

Properties. The Liberty mine, consisting of three patented claims at the old camp of Liberty, 23 miles by road north of Tonopah, belongs to W. E. King and H. J. Kneifel of Tonopah. Couch shows a recorded production of $112,167 from 852 tons mined at this property during 1867–1873. In a recent letter to Director Carpenter, Mr. C. L. Olson of San Francisco reports that to the best of his knowledge the Liberty mine produced about half a million dollars during 1910–1912. During this period, Mr. Olson was mill superintendent and later general manager. The mill treated 35–40 tons of about $18 ore per day. He states that most of his production came from the second and third levels west of the inclined shaft, and adds that a flatly lying fault just below the third level apparently cut off the ore as no ore was found below this level. The present owners purchased the mine from Nye County in 1945, and made a 25-ton shipment from the 100-foot level that averaged about $32 per ton. The principal value of the ore is in silver which occurs in a Permian volcanic.[89] It is said that ore averaging $29 per ton, across 2 feet, is found on the 100-foot level and below. The property has a 600-foot inclined shaft with workings on three levels. A small spring used for domestic water supply is 1 mile south of the camp. Water for milling purposes may be obtained by drilling a shallow well in the flat 8 miles west of the camp.

The Spanish mine, owned by Joe Clifford of Stone Cabin, is 1.5 miles southeast of Liberty. He states that the mine was apparently worked by Mexicans in 1854. He reports finding an old hewn cedar board marked "NWC ESTRELLA." The values here are in silver in a 4- to 5-foot quartz vein appearing to be of the

epithermal-mesothermal type occurring in a clayey chert. The vein bears N. 60° W. and dips 40° NE.; the footwall is a smooth fault plane. Two shafts, one 176 feet deep and the other 66 feet deep were sunk on the vein in the early days. The dump of the deeper shaft is reported to assay $12 in silver. An open cut on the vein 6 to 8 feet deep and about 100 feet long, was made by Clifford. He reports 1,500 pounds of ore taken from this in 1940 netted $94.

The Victory and Defense manganese prospects, owned by E. M. and Mabel E. Booth of Tonopah, are situated 2 miles south of the Liberty mine and 25 miles north of Tonopah by road. The two groups are about 2½ miles apart, the Victory being near the base of the west slope of the San Antonio Mountains, and the Defense being situated on an isolated group of the hills to the west. The prospects are rather similar in that manganese occurs as the mineral psilomelane in seams and bunches in sheared rhyolite. The Victory occurrence is found near an andesite intrusion. At the Defense, the mineral is reported to occur in a highly altered or clayey rhyolite. A placer deposit, in which nodules of manganese are found in sand, also occurs in that area.

The Hall molybdenum property, owned by Lee F. Hand, W. C. Rigg, and C. H. Hall, is situated 1 mile north of the Liberty mine and 24 miles north of Tonopah, at an approximate elevation of 6,000 feet and about 1,000 feet above the floor of the valley 8 miles west. Water for mining and milling is available at shallow depths in the valley and a 30-gallon per minute flow of domestic water can be had at a spring 2 miles south. The power line to Round Mountain and Manhattan passes about 3 miles west. Improvements at the property consist of a hoist, hoist house, and headframe at the collar of the main shaft, together with pipe and rail. All equipment is suitable for exploratory purposes.

A preliminary report by Charles A. Anderson and M. W. Cox, of the U. S. Geological Survey (1945),[90] states that the property was originally a silver prospect and that during 1935–1938 extensive exploration was done by the U. S. Vanadium Corporation, supplemented in 1943 by further exploration of the Metals Reserve Company, to determine molybdenite reserves. The U. S. Bureau of Mines check-sampled the property during the summer of 1942 with results of this sampling reported in War Minerals Report 196. The complete reports of both the U. S. Geological Survey and the U. S. Bureau of Mines are on file with the Nevada State Bureau of Mines.

The areal geology may be generalized as mica schist and sericitic quartzite unconformably overlain by locally silicified limestone and all intruded by a small alaskite stock roughly circular and about 2,500 feet across its surface exposure. The contact area in both the alaskite and the intruded rock contains many quartz veins and in places the alaskite contains at least 50 percent quartz. The molybdenite occurs associated with pyrite and some chalcopyrite in the quartz veins and lenses cutting both the alaskite and the intruded schist. Although the quartz veins persist away from the contact, the sulfide content decreases. The known molybdenite occurrence is limited to the southwest contact and is only exposed in the underground workings. The Survey report suggests that possible continuation of the ore zone may be found along the southeastern extension of the alaskite-schist contact. No work has been done in this area.

Most of the exploration was carried out by the U. S. Vanadium Corporation, all their work being done through the 310-foot 65° inclined shaft. After sinking this shaft from 110 feet to its present level, they drifted southeasterly 1,250 feet on the 280-foot level and cut the mineral zone with six main crosscuts. This company drove a total of 3,500 feet of laterals. From the results of their sampling, and check-sampling by the Bureau, the latter reports 1,300,000 tons of inferred ore containing an average of 0.37 percent MoS_2. This body as outlined on the 280-foot level at a vertical depth of 254 feet, is 1,100 feet long and averages 5[illegible] feet in width. A vertical depth of 300 feet of ore below the lower limit of oxidation is assumed. The last work on the property was done by Desert Silver, Inc., for Metals Reserve Company and indicates the depth of the oxidized zone to range from 85 to 120 feet. This company sunk two vertical shafts, 180 feet and 150 feet in depth, with a total of 215 feet of laterals. They also drilled 354 feet in two diamond drill holes from the surface.

Quite obviously, this deposit is marginal and cannot be worked under present conditions; however, owing to the large tonnage of inferred ore it is important as a possible future ore reserve. Exploration of the other contact areas having the same general geologic conditions found associated with the mineral zone may, as suggested by the U. S. Geological Survey, find more molybdenite and enhance the value of the deposit.

The Blue Jack prospect, located by W. E. King of Tonopah, lies east of the Liberty mine. The ore occurrence is reported to contain gold and silver values associated with chrysocolla. The workings are said to include a 150-foot adit with 20-foot winze and a small raise, and a 30-foot shaft. About 8–10 tons of chrysocolla ore on the dump is said to contain $21 to $24 per ton in gold and silver.

The Florence mine, owned by Walter Bowler of Tonopah, is 25 miles north of Tonopah and 3 miles northeast of the Liberty mine. At present the property is being operated by Allen Kirkendahl and Ira Jacobsen who have made intermittent small shipments in the past few months. The vein occurs in calcareous shale and limestone; it is 2 to 6 feet wide and contains partly oxidized argentiferous galena and copper minerals. The lead minerals are principally in the hanging wall and the copper minerals are found along the footwall. Ore values are mainly in silver. The vein bears N. 70° E. and dips about 30° SE. A 200-foot drift-adit with two stopes to the surface and an inclined winze is the principal working. In addition to this, several cuts and shallow shafts expose the vein for about 250 feet. Improvements include an ore bin of about 20-ton capacity, and a small shop and cabin at the adit portal.

The Cimarron group, owned by Mabel E. and E. M. Booth of Tonopah, lies 8 miles by road or 3 miles air line northeast of the Liberty mine. About $15,000 gross production reportedly has been made from the property. Gold ore occurs here in seams and bunches in brecciated zones in Tertiary rhyolite and latite underlain by what is believed to be Permian andesite. Three adits totaling about 1,000 feet and several shafts totaling 700 feet have been sunk on the property. At present the claims are under option to a group which has driven a cross-cut adit to tap the lower workings of one of the shafts. The operation is under the supervision of W. J. Loring of Tonopah. Improvements consist of a camp with several good buildings, two headframes with small ore bins, and a small mill building. Half a mile down the canyon from the camp is a small spring with the remains of two arrastres. It is generally believed that these mills were used by the early Mexican miners to amalgamate oxidized silver ores obtained from the mines near Liberty.

SILVERBOW

The Silverbow district is 53 miles east of Tonopah and lies on the west flank of the Kawich Range near a point where the range changes direction from southwest to southeast. The district reportedly was discovered in November 1904[91] and made its first

[91] Ball, S. H., Notes on Ore Deposits of Southwestern Nevada and Eastern California: U. S. Geol. Survey Bull. 275, p. 65, 1905.

shipments in 1906.[92] In 1913 a 2-stamp mill is said to have been in operation. Later a larger mill was erected and in 1929[93] a 50-ton flotation mill was installed at the Blue Horse mine. It is believed that the mills operated but a short time.

A few buildings remain in the town of Silverbow and it appears that at one time it was a fair-sized mining camp, having a hundred or more population. As late as 1926 there were about 50 people in camp following a high-grade strike.[94] Roads are in fair condition, it being possible to reach the camp either from the north by way of Golden Arrow, or from the southwest through part of the Tonopah Bombing Range. Water is obtained from nearby springs.

Geology. Ball[95] describes the district as follows:

> The north end of the rugged Kawich Range is, with unimportant exceptions, composed of rhyolites and other siliceous eruptive rocks. The ore deposits lie in rhyolite, which in the vicinity of veins is either kaolinized to a soft chalky mass or silicified, the latter alteration being perhaps more common. The silicified rhyolite is sometimes flinty in texture and is very resistant to erosion, and in consequence forms prominent minor ridges parallel to the veins. In the kaolinized facies the feldspar phenocrysts are either kaolinized or removed in solution, while biotite, if present, is altered to a silvery micaceous mineral. Either facies may be intensely stained red, brown, or yellow by iron salts.
>
> The more important prospects are located in parallel quartz veins or lenses which widen, thin, and often play out, forming mineralized bands whose strike in the district is in many cases north of west. The individual quartz veins vary in width from a fraction of an inch to 5 feet, and these are often connected by minor cross veins. While in many cases the quartz was deposited along pre-mineral faults, in others it occurs along joints, which sometimes form intersecting systems. Quartz likewise often fills the spaces caused by brecciation and forms in solution cavities in the rhyolite. The quartz is, as a rule, white and translucent or colorless and transparent, although in the Blazier tunnel a single vein of amethyst was noted. Crystal-lined vugs are common. Crustification is often beautifully developed, fortification-agate and mammillary forms being common.
>
> The quartz is more or less stained by iron salts, rarely by malachite. In the quartz specks of stephanite, ruby silver, silver chloride, and probably other silver ores occur. Of these, silver chloride is certainly a secondary mineral, and to a limited extent is disseminated in the country rock. Gold occurs free. Silver is the predominant metal, and $1 in gold to $3 in silver is perhaps an average for the whole camp, although in some prospects the silver values are twenty times those of gold. The ore runs from $6 to $250 per ton, while higher values are reported. Since the writer's visit strikes in which gold predominates over silver have been reported.

Properties. The Blue Horse mine, owned by the estate of Ellen McNamara and others of Tonopah, is 1½ miles southeast of the town. The property has had extensive work done on a northwest bearing vein 2–4 feet wide dipping 70° NE. The rhyolite near the vein is silicified, therefore forming a ridge which the vein follows about 1,000 feet. A 100-foot shaft, several cuts, and a 300-foot adit at the northwest end expose the vein along this distance. The adit, now caved at the portal, has had much stoping and appears to be the most recent work. The vein at this end has a very cherty appearance.

This property has had considerable work done in the past, and in 1929 it was equipped with a 50-ton flotation mill which has since been removed. The Silverbow Consolidated Mining Company was operating the property at this time. Weed[96] states, "In mid-1929, company was employing 11 men and mill was operating 16 hours per day, treating 25 to 30 tons of ore ranging from $15 to $20 to the ton." It is said that this company paid $18,000 in royalties on a $35,000 purchase price, but, did not complete the purchase.[97] The company sunk a shaft a considerable distance from the vein but apparently did not cross-cut to the ore as no vein material is on the dump. The only improvement now on the ground is one building in habitable condition.

The Silver Glance group, owned by Mrs. Christina Clifford of Reno, and others, adjoins the Blue Horse on the north. This property was located by Ed Clifford in the very early 1900's,

[92] Lincoln, F. C., p. 182.
[93] Weed, Vol. XVIII, p. 1600, 1931.
[94] Clifford, Christina: widow of Tom Clifford, one of the early locators; personal interview.

[96] Weed, W. H., Vol. XVIII, p. 1600, 1931.
[97] Personal interview with Frank Bell, Tonopah, part owner of the Blue Horse.

believed to be in 1900 or 1901.[98] If correct, this was probably the earliest discovery in the camp. Much of the work on the property was done by Tom Clifford prior to his death in 1928. He made small shipments and during 1940–1942, lessors shipped 160 tons of ore averaging about 35 ounces silver and 0.05 ounces gold per ton. Mrs. Clifford has copies of the smelter returns of lessee shipments.

The workings include several short adits and a lower adit which is equipped with car and track and a blacksmith shop near the portal. The country rock here is rhyolite; the ore is quartzose and contains pyrite.

The Catlin group lies about 2 miles northeast of Silverbow in the next canyon north of the Silver Glance. It is owned by Mrs. Jennie A. Curieux and others of Tonopah. This is one of the older mines in the district, shipments having been made from here as early as 1906. Couch shows 241 tons having a total value of $3,672 shipped from the claims in 1941. Although some underground mining was being done at this time, it is understood that much of the ore came from dumps.

The ore occurs in a quartz vein 2 to 8 feet wide, bearing easterly and dipping 68° S. The silver is found as the chloride near the surface and in sulfides at depth. Rhyolite is the country rock here as elsewhere in the district.

Mrs. Curieux furnished the following information:

> A cross-cut adit, started at the bottom of the gulch below the outcrop, cuts the vein at a distance of 83 feet. A drift extends east on the vein about 60 feet from the adit. A portion of the ore above this drift has been stoped. West of the adit a short drift connects with a shaft 94 feet deep below the adit level. The west side of the shaft has been stoped for a short distance below the adit level and this stope extends to the surface. At the bottom of the shaft, drifts extend east and west on the vein for distances of 15 and 50 feet, respectively. Short cross-cuts, both north and south from the main workings show small quartz veins.[99]

The workings also include several other shafts ranging from 60 feet to 100 feet in depth.

The Hillside mine, in the same part of the district as the Catlin, is reportedly owned by Lawrence Karr, George Dyer, and C. E. Holmberg of Tonopah. The mineral occurrence here is said to be similar to the Catlin group.

[98]Personal interview with Mrs. Christina Clifford.

The workings include an adit with 700 feet of laterals and 500 feet of raises and winzes with sublaterals, a 300-foot adit with 100 feet of other workings, and several shallow shafts. Couch shows a production of $7,307 from 285 tons shipped in 1941. It is believed that most of this ore came from the mine workings.

The shipments from the Catlin and Hillside mines were made by William Anderson and David Eason of Tonopah, who were leasing both properties in 1941.

Several other properties in the district, which apparently now are abandoned, have had much work done on them in the past. Extensive workings were noticed west of the Silverbow camp and an old mill site may be seen on a small hill south of the town.

STONEWALL

The Stonewall mining district is on the north slope of Stonewall Mountain about 17 miles south of Goldfield. Lincoln states that the district was first prospected in 1905 and that small shipments of gold and silver ore were made in 1911 and 1915.

Geology. S. H. Ball describes the general geology of Stonewall Mountain as follows:

> The formations of Stonewall Mountain are, in ascending order, Cambrian limestone, post-Jurassic granitoid igneous rocks, earlier rhyolite, quartz syenite and quartz-monzonite porphyry, Siebert lake beds, later rhyolite, and basalt.

He adds that the Cambrian limestone is practically horizontal except in restricted areas, and,

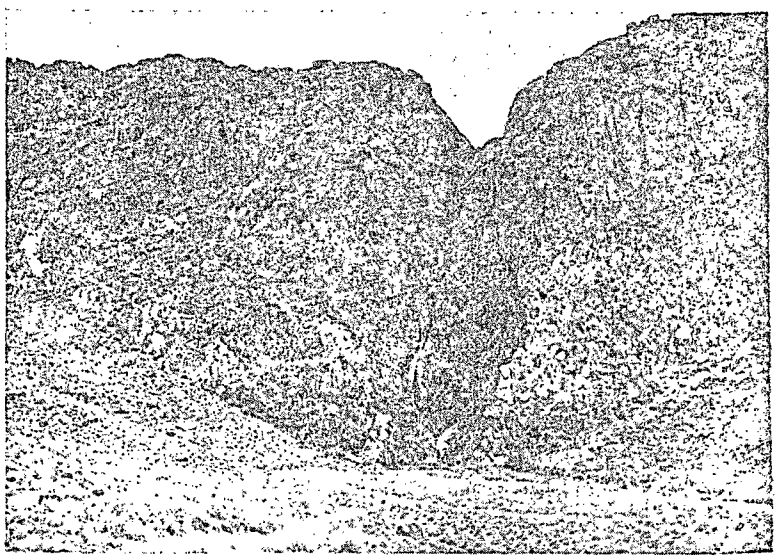
> The most striking structural and topographic feature of Stonewall Mountain is the fault on the front of the mountain group, near Stonewall Spring. This fault strikes N. 65° E. and dips 70° N. Minor faults and sheeting parallel to the main fault occur for a distance of one-half mile south of the mountain front.

Properties. The Sterlog group, now abandoned, was apparently on the parallel veins south of the Stonewall Spring fault. The late Ed Giles of Goldfield stated that a 240-foot shaft had been sunk on a vein containing some silver values. The operating company dropped down the hill about 500 feet vertically below the collar and drove a one mile adit to finally intersect the vein.

The adit was driven in the early twenties and the property was

apparently later abandoned. The large dump is a prominent landmark which arouses interest as it is seen from the highway to Beatty. Its only present purpose is for its drainage which is used to water cattle.

Pius Kaelin has a small two-stamp mill at Stonewall Spring



(15) Stonewall Spring. Note the white quartz on the fault face.

with which he concentrates ore he mines at Gold Crater. He usually does his mining during the winter months and stock piles the ore, which he mills in the summer.[100] This is the only known present activity in the district.

TOLICHA (Clarkdale, Monte Cristo, Quartz Mountain)

The Tolicha district is about 30 miles north of Beatty and for the purposes of this discussion is assumed to include the region along Tolicha wash from the Clarkdale area, near U. S. Highway 95, east to the old camp of Quartz Mountain northeast of Tolicha Peak. The mining properties are at elevations ranging from 4,800 feet at the west end of the district to 5,900 feet at Quartz Mountain. Water is extremely scarce in the area. The known sources are Drum Well at the Sarcobatus Highway Maintenance Station at the west end of the district, Monte Cristo Spring (sometimes called Vignola's Spring) one-half mile south of Tolicha Wash and about 3 miles northwest of Tolicha Peak, and a small unnamed spring 1.4 miles south of the old Landmark

camp in the principal part of the Tolicha district. Monte Cristo Spring has been used in the past as a source of water for the mining activity to the east, and twice has afforded water for small prospecting mills set up below the spring to treat ore from the Tolicha area. The small spring near the Landmark mine may have been dry in some years, otherwise it would not have been necessary to obtain water from Monte Cristo Spring, about 5 miles west. Roads generally are in good condition, if proper routes are taken. Quartz Mountain and the Tolicha district proper are reached from a point on the highway 19 miles north of Beatty from where an improved desert road heads northerly. Access to the Clarkdale area is by way of Tolicha Wash, which crosses the highway 28 miles north of Beatty. The Tolicha Wash road between Clarkdale and Monte Cristo Spring is poor.

Discovery of the district was made in 1905 at Quartz Mountain as per Lincoln. He states that little was done until another discovery was made in 1917. Since then intermittent work has been done in the Tolicha area. Much leasing in the early thirties is reported to have produced about $750,000; however, recorded production from the district is nearly negligible.

Geology. Volcanics are the only rocks found in the district except for a small outcrop of Paleozoic metamorphics mentioned by Ball to be 2½ miles southeast of Tolicha Peak. The volcanics may be generalized as early Miocene rhyolite covered by rhyolite tuffs and breccias and these in turn covered by basalt and basic andesite. Perlite, a volcanic glass with orbicular or pearly structure, of 10- to 20-foot thickness is found between the rhyolite flow and the tuffs for a distance of about 6 miles along Tolicha Wash. In one area, perlite was seen about 1 mile south of the wash, however, the full extent of the flow is not known. The volcanics have a general dip of 10–20° from Tolicha Peak northwesterly, however, due to minor displacements of several faults, the rhyolite is faulted up to the northwest and is therefore in evidence over nearly all of the district. The gold and silver mineralized areas are exclusively in the rhyolite and occur in areas of severe and complex faulting which show extensive hydrothermal alteration.

Properties. The Landmark-Life Preserver group owned by Nick Abelman of Reno, probably has been the most productive property in the district. Gold was discovered here in 1917 and in about 1920 George Wingfield carried out exploration work on the Life Preserver claims under an option to purchase, which was not

the property. Most production has come from the Landmark claims which were operated by lessees who are said to have shipped about $750,000 of gold-silver ore during the early thirties; however, there is no record of this. The ore occurs in brecciated zones recemented by cherty quartz in and parallel to a strong shear zone that bears N. 20° E. and apparently is continuous for the full length of the group, or nearly 1 mile. The rhyolite is partly hydrothermally altered in the ore zone, however, adjacent to the ore and parallel to the shear is a wide zone of silification. As shown on an assay map of the Landmark workings by R. C. Eisenhauer in 1936, ore widths of 5–10 feet have sporadic values of $2 to $15. The Landmark workings consist of a 140-foot inclined shaft, connecting adit, and laterals; all totaling about 1,500 feet. The Life Preserver work, about 3,000 feet southerly, consists of several shallow shafts, adits and connecting workings totaling about 1,000 feet. All ground is standing well. The only improvements are at the Landmark, which has a good headframe and one camp building in poor condition. The hoist and other machinery have been recently destroyed for salvage. Reports have been made on the group by L. F. S. Holland (1923), R. C. Eisenhauer (1936), and Lewis R. Robins (1945). These reports are in the possession of the owner.

Quartz Mountain workings are about 3 miles southeast of the Landmark and consist of several shallow shafts with stopes to the surface and two caved adits. The ownership of the claims is not known. Gold was discovered here in 1905 and the caved adits appear to be the older workings. The more recent work, some of which appears to date about the thirties, was done on a 2- to 3-foot vein in rhyolite with a N. 50° E. strike and 50° NW. dip. The vein has been stoped near the surface for a lateral distance of 100 feet. Much trenching indicates a search for parallel veins. Improvements consist of four old cabins, two of which are comparatively liveable.

The camp of Clarkdale is about 5 miles east of the Beatty-Tonopah highway and just north of Tolicha Wash. Very little information is obtainable about the area except that it had a period of excitement in about 1933 and as per U. S. G. S. Bulletin No. 871 (1936) a $1000 shipment was made at that time. A vein of 1- to 3-foot width, bearing N. 10° E. and dipping 65° E., has been explored by six shafts in 700 feet. The vein is a breccia shear in the rhyolite recemented with quartz. Apparently the property was worked on a block-lease system; therefore, the several shafts in the short distance. Only one of the shafts has a headframe, but this is in fair condition. It is understood that Mrs. Thomas Clark of Tonopah owns the ground.

The Yellow Gold, or Carr's mine, is on the west side of a low north-south ridge west of Clarkdale. The property is owned by C. J. Carr of Goldfield, Earl Mayfield of Tonopah, and others. Discovery was apparently made in the thirties at the time of the Clarkdale activity and there has been intermittent activity since then, particularly following World War II. No known production has been made. Fine free gold occurs here in the brecciated rhyolite which has been highly kaolinized and in places silicified with an opaline silica. Although the gold as found in the workings is free and pans readily, it is usually in vugs containing a little limonite indicating that it was originally associated with pyrite. The values appear to be rather erratically distributed and the determination of mineral control will require careful geologic study combined with considerable assaying. Workings consist of a 150-foot adit, several large open cuts, and an old shaft apparently abandoned. The adit is equipped with car, rail, and a small ore bin. Other improvements are a house in good condition, a few small shacks, and a headframe in fair condition. A hole of about 120-foot depth was drilled in recent years but failed to encounter water; however, it is reported that the drilling did find gold ore of mill grade. The nearest water is Drum Well about 2 air-line miles west or about 5 miles by road.

The Wyoming-Scorpion group, owned by H. B. Kleinstick of Daniel, Wyoming, and others, adjoins Carr's mine on the north. The workings and camp, consisting of a 100-foot vertical shaft with 40 feet of drifting, a good headframe, and a cabin in good condition are about 1½ miles north of Carr's camp. The mineral occurrence is on the same rhyolite ridge as that to the south and appears to be geologically identical. At 40-foot depth in the shaft the rock is reported to assay $5 in gold and silver and no apparent walls were found.

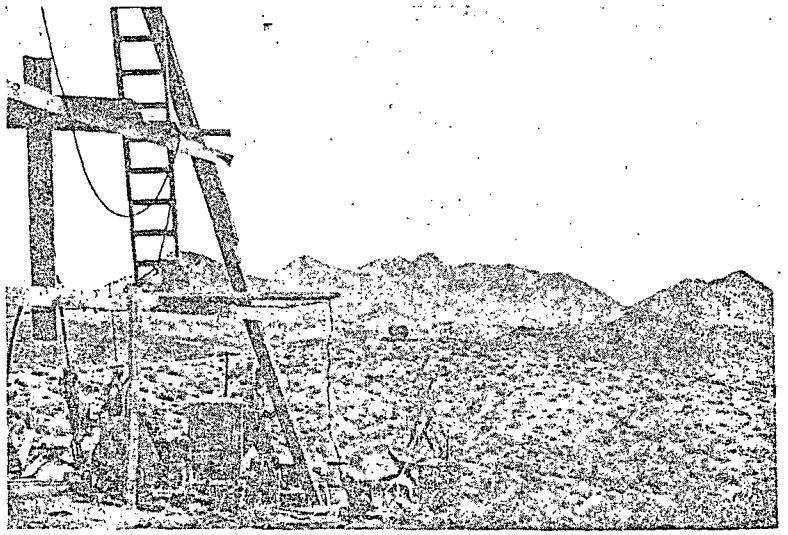
In recent years, much prospecting has been done in this area on the strength of the gold mineralization found at Carr's mine; however, little exploration has been done on these recent prospects except the Wyoming-Scorpion.

TONOPAH

Director Jay A. Carpenter has a bulletin on Tonopah in preparation; therefore, this description of the district will be brief in regard to the Tonopah mines. Mr. Carpenter spent many years in Tonopah and is very familiar with its history.

The Tonopah mining district includes that area in the southern part of the San Antonio Mountains in the vicinity of Tonopah, the county seat of Nye County. Tonopah is situated at an altitude of 6,000 feet, in rolling hills barren except for a very sparse growth of scrub cedar, juniper, and desert brush. It is on the east edge of Nye County and is served by U. S. Highways 95 and 6, which have a junction in the city.

Tonopah, with a population of about 1,300, is by far the largest community in Nye County. Until recent years, mining has been the principal industry here, but since the drop in Tonopah mining activity its position as a point of distribution to a large part of



(16) Diamond drilling north of Tonopah. The town is faintly visible in the distance.

the State's agricultural and mining business has been of greater importance. Its favorable location on the junction of two important highways makes the tourist business also of considerable importance.

James L. "Jim" Butler is credited with the discovery of Tonopah on May 17, 1900. The first claims were staked in August of the same year by Tasker L. Oddie, Wilse Brougher, and Butler. Lincoln reports that Oddie and Brougher took out about 1 ton of ore which returned $600. This was the total production during that year. Tonopah is one of those sought-after discoveries that paid from the grass-roots down. Leases were let and Tonopah had a recorded production of $254,231 from 1,058 tons in 1901.

In 1902, the Tonopah Mining Company purchased the original claims and immediately set out on a major development program.

The principal companies, none of which are now operating, are the Tonopah Mining, the Tonopah Belmont Development, the West End Consolidated, and the Tonopah Extension. In addition to these, Couch shows a large production made by several other companies. His figures show a total recorded production from Tonopah of $147,450,848 from 8,132,685 tons, to and including 1946. In addition to this, the western part of the district, which is in Esmeralda County, has had recorded a production of $2,634,300 from 263,987 tons.

Although Tonopah mining is now at the lowest ebb of its history, important explorations recently conducted may result in the camp again coming into its own. A few years ago the Calumet and Hecla Consolidated Copper Company did much diamond drilling in the northern part of the district. This is now being supplemented by diamond drilling being done by the American Smelting and Refining Company under the direct supervision of P. A. Lewis. This company is drilling about 3 miles north of Tonopah.

Calumet and Hecla results, as shown in their 1948 annual report, were as follows:

> The drilling operation at Tonopah, Nevada, carried on by the subsidiary Tonopah Development Company, encountered quartz veins carrying gold and silver in favorable geological conditions similar to those in the old camp nearby. These results justify further exploration to determine whether or not they are of commercial importance.

Geology. Geology of the Tonopah mining district has been well described by several men who have spent much time in the area. The most recent of these publications is "The Underground Geology of the Tonopah Mining District," by Thomas B. Nolan, University of Nevada Bulletin, Geology and Mining Series, Vol. 29, No. 5, 1935. One of the earliest reports is J. E. Spurr's "Geology of the Tonopah Mining District," U. S. Geological Survey Professional Paper No. 42, 1905. J. A. Burgess wrote "The Geology of the Producing Part of the Tonopah Mining District," published in Economic Geology in 1909, and is one of the common references used.

As the geology of the district has been so well described in other publications, a few brief excerpts from Nolan's work will be considered sufficient here.

Nolan's summary[101] of the rock formations in the area follows:

> Of the seven formations recognized during the field work in 1929 and 1930, two are younger than the ore bodies; the remaining five form the wall rocks of the ore bodies. The folowing list, in which the youngest rocks are at the top, summarizes their relations:
>
> Post-ore rhyolite: Dikes and lenticular masses intrusive into all the other formations.
>
> Fraction breccia member of Esmeralda formation: A volcanic breccia that unconformably overlies the ore bodies and their wall rocks.
>
> West End rhyolite: Sills, as much as 600 feet thick, intrusive into all the older formations.
>
> Extension breccia: Tabular intrusive mass. Found only in the western half of the district.
>
> Mizpah trachyte: A series of surface flows, with minor volcanic breccias, at least 2,000 feet thick originally, but much of this thickness removed by erosion locally.
>
> Sandgrass andesite: Dark lavas, interlayered with the Tonopah formation.
>
> Tonopah formation: Interbedded volcanic tuffs, breccias, and flows, which are conformably overlain by the Mizpah trachyte. More than 1,000 feet thick.

Excerpts of Nolan's[102] description of the ore follow.

> The ore bodies are replacement veins that follow faults or minor fractures and commonly are without well-defined walls. According to Bastin and Laney,[103] ore-cemented breccias, true crustification, comb structure, and other features characteristic of the filling of open spaces are rare or developed only on a small scale. Banding somewhat resembling true crustification, which is locally conspicuous, is possibly to be explained by diffusion during replacement.
>
> The size of the ore shoots and the grade of the ore mined have both varied within rather wide limits. As most of the veins have only assay walls, the price of silver and the methods and cost of mining and milling at the time of extraction have been determining factors as

[101] Underground Geology of the Tonopah Mng. Dist., p. 13, 1935.

[102] Nolan, Thomas B., p. 41, 1935.

[103] Bastin, E. S., and Laney, F. B., The Genesis of the Ores at Tonopah, Nevada: U. S. Geol. Prof. Paper 104, pp. 9-10, 1918.

> to what could be profitably mined. The Mizpah vein has been stoped for 1,500 feet along its strike on some levels, and stope widths of 40 feet were reached on several veins. On the other hand, trial stopes on some of the outlying veins are very small. The average grade of ore mined has on the whole decreased as the district has grown older. Up to 1904 the average value per ton was more than $100, but it dropped to $20 by 1911 and ranged around $15 for many years thereafter. A further drop to $10 occurred in 1930. In some mines considerable quantities of $6 or $7 ore has been mined.
>
> Electrum (probably selenium-bearing), argentite, polybasite, arsenical pyrargyrite, and other silver and base-metal sulphides are found in the hypogene ore, with quartz, a fine-grained pinkish carbonate, and barite, together with altered wall rock, as the gangue. The greater part of the quartz appears to have been introduced earlier than the silver minerals; the carbonate, however, is believed to be essentially contemporaneous with them.
>
> Cerargyrite, iodyrite, and embolite are reported by Burgess to have been abundant in the veins of the Tonopah Mining Co., and Bastin and Laney[104] report some local supergene sulphide enrichment, which, however, they consider 'to have been quantatively much less important than the hypogene mineralization.'

North of the area of Tertiary volcanics, and at the extreme north end of the district, a tungsten occurrence is found on the contact of a granitic intrusion into Ordovician(?) limestone and quartzite. Scheelite is found here in a tactite replacement of wide limestone beds.

Properties. As previously stated, Director Carpenter is compiling a separate publication on the 50-year history of the Tonopah properties, therefore a description of these Tonopah mines will be omitted here.

The Peg Leg tungsten property, owned by John G. Klaus, Charles Joseph, and Earl Mayfield of Tonopah, lies 7 miles by road north of Tonopah. It is on the east side of the San Antonio Range and very near its crest. The old road to Rye Patch passes over the ground. Scheelite occurs here in a characteristic tactite which appears to be a replacement of favorable limestone beds

[104] Bastin, E. S., and Laney, F. B., op. cit., p. 10.

near a granitic intrusive. The contact is extremely irregular and in some cases small pendants of the metamorphosed sediments are found enclosed by the granite. Wide beds of tactite, dipping from 45 to 70 degrees, have been exposed by trenches varying from 18 to 45 feet in length. Samples along the full lengths of these trenches are said by the owners to have returned 0.24 to 0.70 percent tungsten trioxide. The samples indicate a large tonnage of ore averaging 0.5 percent tungsten trioxide. The owners state that a 5-ton sample mill run in a dry mill near Mina, returned about 0.6 percent tungsten trioxide. As the ground is rolling and easily accessible, and the ore zones are not extremely steep in dip, it appears that this property could be easily explored further with more trenches and diamond drilling.

Rock cutting and polishing equipment of unusually large size for the preparation of decorative building materials and accessories, has recently been installed in Tonopah by Edward L. Connolly. Mr. Connolly states that the equipment will accommodate a maximum size rock 6 feet by 6 feet by 14 feet. He states that the cutting is done with a 60-inch diamond insert circular saw and that the usual size slab is 25 inches by 96 inches by 1 inch thick. He has, in Tonopah, pieces of arragonite weighing up to 16½ tons which were mined in the Royston district.

The diamond drilling of one hole on the Imca group, part of a block of 64 claims owned by Herman Budelman of Tonopah and Fred Ninnis of Oakland, was conducted for the owners by Boyle Brothers of Salt Lake City during the summer of 1950. The group lies southerly of the Tonopah "76" Consolidated Mining Company ground. The Tonopah Times Bonanza reported that if results were encouraging more drilling was planned for the spring of 1951.

TRAPPMANS

The Trappmans mining district is about 40 miles by road southeast of Goldfield and 2 miles south of the Wilsons mining district. It is just outside the present boundaries of the Tonopah Bombing and Gunnery Range. S. H. Ball[105] reports that the district was discovered by Hermann Trappman and John Gabbard in June 1904. Lincoln states that the district was worked but a short time and abandoned. There has been no report of activity in the area since the early days.

In describing the geology of the district Ball states as follows:

> The prospects are in granite, and three distinct periods of quartz formation were noted—first, quartz lenses probably of pegmatitic origin; second, quartz veins of distinctly later formation, which in one place are said to cut the rhyolite (dikes); third, quartz veins of a third generation, which cut the second. The latter class of veins is often well crustified.

[105]Op. cit., U. S. Geol. Survey Bull. 285, pp. 68-69.

TROY (Irwin Canyon, Grant Canyon)

The Troy mining district, which includes Troy and Irwin Canyons, lies on the west side of the Grant Range about 30 miles by improved dirt road south of Currant on the Tonopah-Ely highway. The Grant Range rises to 11,268 feet in Troy Peak, and the mining properties are at elevations ranging from 6,000 feet in Irwin Canyon to 8,600 feet at the old Troy mine at the head of Troy Canyon. Winter temperatures and snow conditions are usually severe. Water for all mining purposes is plentiful and in Troy Canyon the supply is enough to furnish a little electric power.

James M. Hill, in U. S. Geological Survey Bulletin 648, states that the Troy ore deposit was discovered in 1868 and purchased by an English company in 1869. This company built a 20-stamp mill with Stetefeldt (chloridizing roast) furnaces at the Troy camp 5 miles down the canyon from the mine; however after the expenditure of much money the mill shut down in 2 years or less for lack of ore. The same company also did some work south of the camp, near the more recent activity in Troy Canyon. Mining in Irwin Canyon started with the location of a group of claims by F. L. Irwin in 1905. Since that time there has been intermittent activity in this area.

Geology. Hill gives considerable information on the geology of the district. He states that the oldest rock is a thin-bedded lime shale and argillite which has been severely folded in some areas. The argillite seams are often metamorphosed to a mica schist. Hill estimates this formation to be about 3,000 feet thick. It is well exposed between the Troy mine and camp, and is also seen near the mouth of Irwin Canyon; here it is intruded by numerous granitic sills.

A persistent bed of fine-grained vitreous white quartzite overlies the lime shale and is found near the mouth of Troy Canyon and on the ridge north of Irwin Canyon. This quartzite bed is estimated by Hill to be about 200 feet thick and is overlain by a massive limestone.

Both Hill and J. E. Spurr, in the latter's U. S. Geological Survey Bulletin 208, correlate these formations with the Ordivician section of Eureka.

The sediments have been intruded by a stock of quartz monzonite west and northwest of the Troy camp which has a general northeast trend. The properties of latest activity in the district are either on or near the contact of the granite rock with the sedimentaries. Hill mentions a dike of glassy rhyolite north of the Troy camp as the only later intrusive observed. A few basic dikes were noticed on some of the claims.

Properties. The old Troy mine 5 miles up the canyon from the camp and the Locke mine 1 mile southwest of the camp, is now owned by the Old English Gold Corporation headed by Joseph Hafen of Provo, Utah. The historians Thompson and West in "History of Nevada," published in 1881, state that the mine was discovered in 1867 by A. Beatty. They also state that the town of Troy was laid out in 1869 and soon had six business houses. The mill was reportedly built in 1871 and only ran 6 months, when it was decided that the ore was too low grade. The present owners acquired the property in about 1936 and did some exploratory work on that part southwest of the camp. A small flotation mill was built shortly after this, and in about 1946 a mill of 50-ton capacity was built at the mine. The mill is powered by a Diesel engine and recovery is by jigs and flotation. Water is obtained by a 6-inch pipe line from the upper part of Troy Canyon. The property has not been operating since the summer of 1949.

A 200-foot cross-cut adit with a 135-foot winze is just above the mill and is the principal work done by the present owners. The adit cuts 26 feet of a flatly-dipping vein striking northeasterly and dipping southeast. The winze is in the hanging wall of the vein; and considerable "gopher-like" stoping, apparently following higher-grade parts of the vein, has been done off the north side of the winze.

The work near the mill is on the what appears to be the northeast extremity of the vein. From here the vein can be traced southwesterly along the contact between the quartz monzonite and the limestone for about 1,100 feet, over which distance much exploratory work and some mining has been done. The vein also can be seen for 2,000 feet more; however, no appreciable work has been done on the extreme southwest portion. Preliminary sampling of the mill adit and the workings along the vein, gives a reported average of over $10 per ton. Ore shipped to McGill and Salt Lake smelters from near-surface work southeast of the mill adit is said to have run $20–$40 per ton.

Very little has been done at the old Troy mine since the early days. Thompson and West mention a 300-foot shaft and 700-foot adit. Hill mentions several workings all caved. He states:

> The main work was through an incline shaft, said to be 500 feet deep, that was under water in October, 1913. A tunnel about 100 feet below the collar of the shaft was caved near the mouth, but is shown by the dump to be of considerable length. Other tunnels run north and south from the gulch on the lode. The northern tunnel could be entered for a short distance. These workings are on large lens-like bodies of white quartz which dip 40° to 50° E., parallel to the thin-bedded, black lime shales (Ordovician Pogonip) on the east limb of an anticline. . . .

As per information from Mr. P. A. Lewis, one of the veins on the north side of the canyon is 3–4 feet wide, strikes N. 30° E., and dips 40° SE. An adit, now caved, was driven on this vein and some narrow stopes come through to the surface. In regard to the ore, Mr. Lewis states:

> The quartz is pure white, in the main bony, containing varying amounts of principally azurite and malachite. However, pieces of sorted ore on the dump show pyrite, chalcopyrite, arsenopyrite, and specks of galena and sphalarite. Although factual data are lacking, it is inferred that the structures worked were 3–4 feet wide containing spotty copper values probably with some lead, silver, and gold.

The caved inclined shaft and adit mentioned by Hill lie east and southeast of these working, apparently on a parallel vein.

The Leadhill claim and mill site, owned by J. J. Steele of Las Vegas, lie near the mouth of Troy Canyon. A small mill building, with no machinery, and two other buildings are on the creek just below the mouth of the canyon. The mining claim and workings are a mile southeast of this camp. Two adits have been driven on seams and replacements of galena and pyrite in flatly lying thinly bedded limestone and shale about 1,000 feet southwest of the quartz monzonite. One adit follows a small basic dike intruding the sediments. Ore found contains galena and pyrite in about equal quantities. It appears that a small trial shipment of ore was made in recent years; however, it is doubtful that more than this was ever produced.

Irwin Canyon is 25 miles south of Currant and the Irwin Camp

is 7 miles east of Railroad Valley. Just north of the camp is several hundred feet of work, done years ago, on narrow high-grade gold stringers occurring in the quartz monzonite. The owner claims the ore here is worked out. About one-half mile north of these workings is the Mayolli claim, which has two 80-foot flatly inclined shafts on a contact vein. The workings appear to be on faulted segments of the same vein which bears northerly and dips 17° E. In one shaft the quartz is 4–6 feet wide and 100 feet of drifting has been done from the bottom. Above this and a little to the south, the other 80-foot shaft is on 2–4 feet of quartz, and 20 feet of drifting has been done here. The ore shows a little galena and the owner claims the ore in the two shafts will average from $8 to $16 per ton in gold and silver. A grab sample of ore of the dumps assayed $5.60 gold per ton. Each segment or vein has limestone and shale on the hanging wall and quartz monzonite on the footwall.

A small mill at the Irwin camp is reported to have been installed in 1940. It consists of a small crusher, a 4-foot ball mill and jig, all powered by a Fordson tractor. The equipment is not housed and appears to have been used but little.

Some work has been done in Grant Canyon, 4 miles north of Irwin Canyon and will here be considered as part of the Troy district. The North Star claim, owned by Margaret McMullin of Ely and Joe Pitino of Los Angeles, is reported to have some lead-silver ore occurring on a granite-lime contact. A 100-foot adit has been driven on the ore. This claim is reported to be an old discovery, originally made in the sixties and relocated several times. The present owners obtained the ground in 1946 and have used it for more of a summer lodge, as the abundance of trees and water make it a desirable vacationing spot.

A group of claims in Grant Canyon, owned by Mary A. Fuller of Los Angeles, is said to have considerable work including a 350-foot adit. Lead, silver, and gold values are reported to occur in quartz veins in shale.

Mrs. Lettie Carbis of Preston reports that she has manganese on her Rainbow group of claims in Grant Canyon.

TWIN RIVER (Millett, North Twin River)

Heretofore, Twin River and Millett have been described as independent mining districts. As they include rather small areas which have been characterized by only minor activity for many years, it appears reasonable to now describe them together as one mining district. Also, the activity on the west side of the Toiyabe Range, which has not been included in one of the recognized districts, is herewith included under Twin River.

With these inclusions, the Twin River district covers the east flank of the Toiyabe Range approximately from McLeod Creek south to South Twin River and that part of the adjacent west flank of the range south of the Washington district. Nearly all the activity has been on the east side of the range and is easily accessible from oiled State Route 8A. The Millett Service Station near the north end of the district is 42 miles from Austin and 76 miles from Tonopah.

Winter weather conditions are usually severe at the higher altitudes of the district. The proper reconstruction and maintenance of some of the roads would allow much of the area to be worked through the winter months if the operation was justified. At present two prospects near the head of Ophir Canyon use a road over the summit from Reese River Valley which is blocked by a large snow bank all but 4 to 6 months of the year. Reconstruction of the old road up Ophir Canyon above the Murphy mine would make these properties more easily accessible for a much greater part of the year. Water is plentiful in all parts of the district and, at various times in the distant past, mills have been built in several places. These mills have all long since been removed.

It is believed that the first discovery of ore in the district was made in Ophir Canyon in June 1864[106] when native silver was found in the outcrop of a vein. This was later known as the Murphy mine.

Although production from the Murphy mine was very early, data from the company records have been published.[107] They indicate about $700,000 production to the time of suspension of work in 1868. Couch shows an additional $54,548 recorded Murphy mine production during 1875–1890, and $2,401 from the district in 1941. As the Murphy mine was the only large operation, the district production is probably not much greater than the $757,000 total of these figures. The values of the ores are in gold and silver, with most of the early day production having been in silver.

Geology. The Toiyabe Range rises steeply on its east slope from 6,000 feet altitude at the base in Big Smoky Valley to a general ridge elevation of over 10,000 feet and to 11,775 feet on Arc Dome, the highest point. More gentle slopes are prevalent on

[106] Stretch, R. H., Nevada State Mineralogist's Report for 1866, p. 60, 1867.
[107] U. S. Geol. Expl. Fortieth Par., Vol. III, p. 392, 1870.

the west side and the foot of the range is about 1,000 feet higher than on the east side.

A granodiorite intrusion, probably Jurassic(?),[108] is exposed in the district along much of the low east flank of the range and in a small area near the head of Last Chance and Ophir Canyons. The granodiorite intrudes Cambrian quartzites near the northern part of the district and Permian quartzites and slates between Ophir and North Twin River Canyons. Muller and Ferguson show the Cambrian to be overlain by Ordovician slates and limestones, which in turn are overlain by the Permian quartzites and slates. Permian volcanics, which in much of the area have the general appearance of slates, overlie the sedimentaries at the higher elevations. At the north end of the district these volcanics are largely on the west flank, and near Twin River they are entirely on the east flank of the range. Tertiary rhyolite is found at lower elevations of the west flank in the north and covers all the southwest part of the district.

Metamorphism has been intense in much of the area, particularly in the southern part of the district. In a granodiorite-slate contact area along North Twin River it is often difficult to differentiate between igneous and metamorphosed sedimentary rocks.

Gold and silver are the principal valuable constituents of the ores; however, lead and zinc are found throughout the district and some copper minerals occur in minor quantities. The Murphy mine was essentially a producer of silver ore and, except for possibly one or two minor ones, the other ore occurrences have contained either gold or lead as their chief economic metal. High-grade gold ore has also been taken from a claim adjacent to the Murphy mine. Most ore in the district usually is found to occur sporadically. The Murphy mine may be an exception, however, as little is known about its geology.

Properties. The Murphy mine, also known as the Ophir, is in Ophir Canyon 5 miles west of the highway. The road to the property is in good condition except for a few short pitches which may prove difficult for the movement of heavy equipment. The mine is at an elevation of 8,000 feet and it may be presumed that heavy winter snows would hamper operations. Water for mining purposes is plentiful in Ophir Creek as well as in the mine.

The property is owned by Mrs. Goldie Lastreta of San Francisco. So far as is known, little or no production has come from

[108] Ferguson, Henry G. and Muller, Siemon W., Structural Geology of the [illegible] and Tonopah Quadrangles, Nevada: U. S. Geol. Survey Prof.

the mine since shortly before the turn of the century. The mine was reopened in 1917 and operations were suspended in 1923, but it is believed that very little production was made during this period. Another attempt, apparently short-lived, was made to open the mine in 1935.

The total production from the mine appears to be $754,548. Of this amount, Couch shows only $54,548 recorded. This was made during 1875–1890 from 1,258 tons, therefore having a value of $43 per ton of ore. The $700,000 production by the original company, prior to 1875, has been verified. Of this amount, over half was made in 1867 and yielded $111 per ton. The ore assayed from $130 to $150 per ton.[109]

This case of discrepancy between reliable known production and that given to State authorities, illustrates the laxity in enforcement during the early years of the mine taxation law, known as the "bullion tax," requiring sworn production records as provided for in the State's Constitution of 1864. However, greatly exaggerated production figures, as some of those given to Lincoln, compared with Couch's recorded figures, cannot be substantiated and can be well discounted as being tinged with hearsay and optimism.

The ore occurs in a quartz vein striking northerly and dipping about 45° E. in shale about 1 mile west of its contact with granodiorite. James D. Hague[110] a noted authority, states that the vein is a hard compact quartz, 1 to 12 feet in width, averaging 8 feet. Usually only about 2 feet of the vein is ore and is found on either wall or in the center of the vein. He describes the minerals as chiefly tetrahedrite, stibnite with ruby silver, fine-grained argentiferous galena, and much sphalerite. The tetrahedrite and sphalerite are both silver bearing. Some native silver is also mentioned in the ore and it may be assumed that this is found with the chloride in the near-surface part of the vein. Pyrite accompanies the ore and when fine-grained often indicates the better ore.

The Ophir workings reportedly consist of a 360-foot 45-degree inclined shaft with four or five levels, all totaling about 2,000 feet. The shaft, nearly full of water, is north of the creek, only a few feet above the water level. All levels were driven north under the hillside, and as indicated in a section by Hague,[111] the workings apparently encountered an east-bearing fault dipping 50° N.

[109] U. S. Geol. Expl. Fortieth Par., Vol. III, p. 387, 1870.
[110] Indem., pp. 383-384.
[111] Op. cit., 40th Par., Plate XXVII, fig. 4, p. 385.

Exploration north of the fault consisted of drifting north about 100 feet on a quartz seam that resembled the vein and cross-cutting west; however, no ore was found north of the fault. Whether later operations were able to develop new ore blocks is not known.

Hague[112] gives very complete information on the operation of the mine and mill. In explaining the hardness of the rock, he states:

> Steel, 1⅛-inch in diameter, is used for drills, and it is not uncommon to dull 30 of them in boring a 2-foot hole. Two men are required constantly to sharpen the tools for 44 miners.

He describes the operation as follows:

> In June, 1868, there were 44 miners employed, nearly one-half of whom were stoping. Including fillers, landers, rock-pickers, etc., the mining force was 70 men. At that time the mine was producing about 12 tons of milling ore per day, to obtain which some 50 tons of rock were mined and raised for assorting. Labor was then employed chiefly by the day at an average cost of $4, in coin, for miners. The machinery at the hoisting works at the mouth of the incline consists of an engine, having a cylinder of 12 inches diameter and 24 inches stroke, driving a winding wheel by friction-gear and a pump by means of toothed pinion and wheel. The pump is an eight-inch drawlift raising water from the bottom of the mine, being extended as the depth of the incline increases, in manner similar to that already described in a foregoing chapter. The mine is very wet and the pump must be constantly employed while mining work is in progress.

The mill had 20 stamps, 8 roasting furnaces, and 8 amalganating pans, and is said to have made an 80 to 85 percent recovery. Hague's figures show the total cost of milling to be $40.55 per ton of ore milled. During the year 1867 the company mined and milled 3,847.5 tons at a total cost of $326,971.51. The production of bullion amounted to $427,227.67, leaving a profit of $100,256.16.

Hague[113] explains the reasons why the mine shut down in 1868:

> The total product of the mine from the date of organization to the time of its suspension of work in the summer of 1868 is shown by the company's books to be about

[112]Op. cit., 40th Par., p. 386.

$700,000. Notwithstanding this large production, the greater portion of which was obtained at a fair profit above the actual running expenses, the company has suffered great pecuniary embarrassment, and, late in 1868, became bankrupt. This last step appears to have been due more to the lack of a proper understanding or of harmonious cooperation in the management of the company's affairs than to any unfavorable developments of the mine; although, just at that time, the amount of ore in sight was less than usual. The rich ground opened for stoping had been exhausted, and further work was necessary in order to reach the deposits believed to be accessible. The chief cause of the embarrassment, it is said, was the large outlay made at the beginning of operations, in costly surface improvements, involving not only all the money advanced by the stockholders, but all the profits of the mine besides. The mill alone cost $183,000. Meantime the mine was never opened sufficiently in advance of the demands of the mill, so that the latter was often employed to only a part of its full capacity, thereby enhancing the costs of treatment; and it was deemed necessary in the summer of 1868 to close the mill until the mine could be more extensively opened, and ground thus prepared for more economical operations. The production of bullion being thus suspended, a call upon the stockholders for further capital became necessary; but owing to the existing discouragement on their part or to a lack of a proper appreciation of the true condition of affairs, the assessments were not paid and the company became embarrassed. The property was attached and all mining operations were suspended. The amount of indebtedness was comparatively small, not exceeding the actual value of the supplies and material on hand and available for use; saying nothing of the mill, hoisting machinery, and improvements that had cost about $250,000. In the summer of 1869 the property of the company was sold by the assignee, and was purchased by a new organization known as the "Cambridge Silver Mining Company." The new owners employed a small force in the autumn of last year (1869) in draining the mine and extending the explorations; but this work was shortly after suspended without obtaining definite results.

The above account of the failure of this company over 80 years ago, in spite of the large monetary value of its production, is of intriguing interest because of similar troubles and failures at many mines extending over the years to the present time. However, the engineer at a flooded or badly caved mine is mentally disturbed between the hopes inspired by accounts of sudden disaster or mismanagement, such as above, crippling a rich mine, and fear that diminishing tonnage and values might be the basic cause.

The last activity at the Murphy was during 1935–1937 by the Ophir Canyon Mining Company,[114] which took over the property from Walter Trent. Trent operated the mine during 1917–1923 as the Nevada Ophir Mining Company and was president of both companies. Drainage of the mine was handled through a 12-inch churn drill hole which was drilled 210 feet east of the shaft. It is believed that Trent did little more than unwater and sample the workings. The dumps of the mine show that considerable sorting and screening has been done and it is assumed that much of this was done about this time.

At present, the rock ruins of several old buildings remain and the headframe of the shaft last used also stands. Some of the old buildings could be improved and used for temporary housing.

The Grizzly patented claim, also owned by Mrs. Goldie Lastreta, is just southeast of the claims of the Murphy mine. High-grade gold ore occurs here in a narrow quartz vein that strikes southwest and dips nearly vertically. Only near-surface work has been done on the claim and it is understood that an appreciable quantity of high-grade gold ore has been mined and milled here by small-scale methods. John Martin reportedly mined here in 1924 and processed his ore in a water-powered 2-stamp mill on Ophir Creek. No information on production from the claim is available.

The Gruss mine, consisting of the Aderondike patent and several unpatented claims, also owned by Mrs. Goldie Lastreta of San Francisco, is on the south side of Ophir Canyon near its head. The property is at an altitude of nearly 10,000 feet, therefore winter weather conditions are severe. The road to the claims comes over the Ophir Summit, at an altitude of 10,115 feet, and is usually blocked by a large snow bank just east of the summit. This property was worked by Ronald M. Gruss until his death a few years ago. No known production has been made. The ore occurrence here is an argentiferous galena, partly oxidized and

[114]Mines Register, Vol. XIX, p. 684, 1937.

containing some copper, occurring in narrow quartz veins in granite. Good grade ore has been reported found here, but it is believed that the occurrences are sporadic. The workings consist of a 300-foot adit, cutting a 20- to 24-inch vein, and a 150-foot adit with a 60-foot winze exposing some high-grade lead-silver ore. In addition, there are several other short adits and some caved workings. Improvements consist of two sheet-iron buildings in good condition. Water is obtained from a large spring near the camp. Any future plan of extensive work on this property should include the reconstruction of the road down Ophir Canyon to the Murphy mine. This would make the mine only about 8 miles by road from the highway in Big Smoky Valley and more easily accessible.

The Dallimore-Douglass claims, located in 1948 by George Dallimore, Robert L. Douglass and Charles H. Pefley of Reno, are about one-half mile southeast of the Gruss mine. The two claims endline on the ridge separating Ophir Canyon from Last Chance Canyon to the south. On the Last Chance side of the ridge, a north bearing quartz vein containing high-grade galena with chalcopyrite has been exposed in an open cut. The vein zone is about 3 feet wide and dips 30° W. It is made up of several smaller quartz veins which are sometimes together to form a wide face of hard quartz, but usually separated by "horses" of hornfels. Several hundred feet over the ridge to the north are other cuts on quartz seams containing similar mineral occurrences; some of the exposures here may be a continuation of the vein to the south. The deposit is believed to follow a shear zone, probably traceable for 1,000 feet or more, with sporadic occurrences of high-grade lead-silver ore. The silver content is reported to be in the ratio of 1 ounce of silver to 1 percent of lead. The granodiorite contact with the meta-volcanic is one-half mile west of the property and the volcanic becomes more silicified as the contact is approached.

High-grade ore, found on the dump of the best exposure, came from a pocket having a 3-foot face of nearly pure mineral. The possibility of a few larger "plums" or lenses of this sort of ore would make the property attractive as a small scale operation.

The White Horse claims in Last Chance Canyon, owned by J. W. Berg of Round Mountain, are situated about 3 miles above the mouth of the canyon. This and other groups in the general area have been located on narrow veins of high-grade gold ore. The owner has assay returns of several samples taken over widths of 5 inches to over 3 feet, having a gold content of $3 to $245 per

ton with the greater percentage of the samples over $20. He states that the ore occurs in a calcareous shale and has been explored by a shallow shaft and a short adit, now caved.

The Korf property, also on stringers of high-grade gold ore, is near the Berg ground. It is said that Korf made his living off these claims before his death in 1930. The present ownership of these claims is not known.

Placer claims below the mouth of Ophir Canyon are owned by Charles Joseph and others of Tonopah. Only minor prospecting has been done on the ground.

The Sullivar mine, now located as the Summit group by Philip and Louis Meyer of Austin and W. H. Thomas of Tonopah, is about one-half mile northwest of the Ophir Summit. The property was worked by Sullivar until his death a few years ago. There is no known production, although much near-surface work has been done on the claims. The country rock here is all rhyolite and it appears that the work has been done on small stringers containing gold. The partly altered surface rock probably contains a concentration of gold values, giving incentive to exploration, but to be of commercial value these seams must occur with close spacing. It is understood that the present owners are attempting to develop an area in which the rhyolite and the seams together may be mined as ore.

The Brothers Gold group, also owned by the Meyers brothers of Austin and Thomas of Tonopah, is on the ridge between New York and Mohawk Canyons on the west flank of the Toiyabes. A cropping of hard rock about 85 feet wide and 300 feet long contains gold values and, as described, may be a part of the Permian volcanic. During the summer of 1948, Homer Black of Reno did considerable exploration here in an attempt to develop ore for a large tonnage operation. He reports[115] that sampling of a 32-foot trench on the surface gave a value of $12.50 per ton, with the value of gold and silver contained about equal. Two adits, about 80 feet and 40 feet in length, were driven into the cliff-like outcrop and although some of the first drill cuttings assayed well, the value of the rock in the faces finally dropped to about $1 per ton.

The Hanlon mine, apparently owned by Walter Hanlon of San Francisco, is in Crane Creek 8.5 miles by road east of the Reese River Ranger station. A 1,000-foot adit has been driven in the meta-volcanic, following small stringers showing pyrite and possibly containing gold values. The adit is on the creek and is

[115]Personal interview.

driven southeast into the steep south canyon wall. A good house with lean-to addition is near the portal of the adit. The camp gives the general impression of being maintained as a hunting lodge rather than for mining purposes.

The Teichart property, locally known as the Antimony mine and owned by Alma A. Teichart and Claire G. Knowles of Sacramento, is in North Twin River Canyon 5 miles west of the highway. The workings, which have had little or no activity in many years, are on the north side of a precipitous part of the canyon. Little is known about the history of the property; however, it is believed little or no production has been made. It appears that some work was done here in the early thirties.

Two adits have been driven on the contact of the granodiorite with a diabase dike. The upper adit, several hundred feet above the creek, follows a 3-foot quartz vein containing much pyrite with some sphalerite, bornite, and galena. Notwithstanding the name, Antimony mine, locally applied to the property, no antimony minerals were noted. A shallow shaft has been sunk on the vein at the portal of the upper adit. The lower adit is about 300 feet long and follows the contact. It appears that no ore was found there.

On South Twin River, extensive workings and the ruins of an old stamp mill are reported, but nothing is known about the property except that it is said to have been worked in the twenties.

In the northern part of the district, the stone ruins of an old mill site at the mouth of Park Canyon are an excellent landmark and indicate the activity of the past.

The Millett mine is 1 mile east of the Park Canyon mill site, on the brow of a ridge overlooking the valley. The dumps of several adits may be seen in the granodiorite near its contact with a limestone pendent to the southeast. An ore bin and the remains of a frame building indicate that some work was done here in about the thirties. The present ownership of the property is not known.

The Viken claim, owned by Kenneth J. Rogers of Sparks, is in the vicinity of the old Millett mine. The owner reports that about 60 feet of the vein was stoped in the early days to a depth of 35 feet. The ore occurs as narrow quartz seams up to 10 inches wide in the granodiorite and reportedly contains $10 to $165 value in gold and silver per ton. In addition to the old workings, the owner has sunk a shallow shaft and has done some trenching.

The North Twin claim, owned by Ben Bowles of Reno, is in the south fork of Park Canyon 1 mile south of the old mill site. Samples from an 18- to 20-inch vein in limestone are said to contain

20 percent lead, 15–20 percent zinc, $3 gold, and 20–55 ounces silver per ton. The workings consist of a 25-foot shaft and a few shallow cuts.

The Giant patented claim, owned by Lyster Farrington of Big Smoky Valley, is in the north fork of Park Canyon 1½ miles west of the old mill site. The upper mile of the road to the property is washed out. Couch reports a recorded $10,475 production from a total of 245 tons in 1937 and 1941. The property was being worked during 1937–1938 and apparently again in 1941. Ore shipped in 1937 reportedly[116] averaged 0.15 ounces gold, 40 ounces silver and 4 percent lead per ton. The ore occurs as lenses in limestone near its contact with granodiorite and in the vicinity of diabase dikes. The production has come from a large surface underhand-stope and a nearby adit with small stope. The ore widths in these workings are about 7 feet and 4 feet, respectively.[117] An 800-foot aerial tram and 10-ton ore bin, still on the ground, were used to bring the ore down a steep mountainside to the road in the canyon bottom. A cross-cut adit driven several hundred feet from a point about 50 feet above the road has not encountered the downward extension of the ore. The portal of this adit is now caved. Samples of ore found on the property contained considerable sphalerite in addition to the lead minerals. A large cabin on the property, built in 1938, is in rehabilitable condition. Water for domestic purposes may be obtained from a small flow in the canyon.

The Valley View and Foothill claims, owned by Fred Linsea of Reno, are 1 mile north of the old Park Canyon mill site. A stringer of ore reported[118] to contain 15 percent lead, 26 percent zinc, and very little silver is exposed in a short adit. The ore occurs in limestone near the granodiorite; the contact is a short distance above the workings.

The April Fool patented claim is believed to be part of the old Buckeye mine described by James D. Hague.[119] The claim is one of three situated near the head of Summit Canyon and is owned by Stanley Baldwin. In describing the property Hague states:

> Some of it (the ore) is very rich, and various lots have been taken to Austin and worked at the Manhattan mill, yielding about $300 per ton. In August, 1869, a very little over 9 tons were thus worked, yielding, on the average, $283.52 per ton. Operations were still in progress at this mine at the last accounts. There is a large amount of ore on the surface, estimated to be worth $100 per ton, not rich enough to warrant expensive transportation to Austin and high prices for milling, which must be reserved for a mill near at hand.

[116]Minerals Yearbook: 1939, p. 410.

[117]This information from personal interview with J. P. Hart, private consultant, who examined the property in 1938.

[118]*Personal interview with owner.*

[119]U. S. Geol. Expl. 40th Par., Vol. III, p. 383, 1870.

Nothing is known about the workings; however, Couch shows a recorded production of $214 from 2 tons in 1941. The values are principally in gold.

The Blue Bird No. 1 and Manual No. 1 patents, owned by Eleanor Hobson and Shelby Bell, respectively, of Tonopah, are in the same general vicinity as the April Fool and are believed to be part of the original Buckeye group.

TYBO (Hot Creek, Keystone, Empire)

The camp of Tybo is 8 miles northwest of a point on the Tonopah-Ely highway, 60 miles northeast of Tonopah. It lies in Tybo Canyon on the east flank of the Hot Creek Range at an elevation of about 6,700 feet. In addition to the Tybo mine itself, the Tybo district is here assumed to include that part of the Hot Creek Range from Warm Springs at the south, to the vicinity of Hot Creek Canyon on the north. At various times local areas were known by different names. The northern section in particular is often referred to as the Hot Creek district.

Domestic water for Tybo is obtained from springs above the camp and more than enough water for milling purposes is pumped from the mine when operating. The nearest transmitted electric power is 40 miles distant at Manhattan. During the operation of the Treadwell-Yukon Company a power line was installed, but this was removed in the late thirties when the company liquidated its assets. Roads to the camp are excellent. Of the 68 miles from Tonopah, only 8 miles are not paved highway but are improved and partly graveled.

Lincoln states that the Tybo district was discovered in 1865 by an Indian who showed it to white men in 1866. Thompson and West refer to the discovery of the "Empire" district which took in part of the town of Tybo in 1866. They add that the Hot Creek or northern end of the present district was also discovered in 1866 and that the "Milk Spring" district, south of Tybo, was organized in 1867; this area is now part of the Tybo district. The name originated from the appearance of the water in a large spring.

The town of Hot Creek was apparently quite active in the early days. Thompson and West state that it was divided into an upper and lower camp and each had a stamp mill, although neither mill operated much. The town was the property of J. T. Williams and was the site of a very elaborate stone building. This building, later gutted by fire, was restored in the early 1900's; it still stands at Hot Creek. It is said that Williams made a sizeable stake from an early discovery in the Danville district, with which he purchased and improved the Hot Creek site. The town is reported to have had a population of 300 in 1868, but is said to have dropped to 25 in 1881.

Tybo itself is very well described by Henry G. Ferguson.[120] He states that the 2 G lode was discovered in 1871 and a smelter was erected in 1872. The company failed in 1879 after most of the oxidized ore had been mined and they could not treat the sulfides. During the 1872–1879 period, 61,439 tons of ore was smelted yielding 11 percent lead, 27.5 ounces silver, and 0.24 ounces gold per ton. Director Carpenter states that the first mill used a chloridizing roast and amalgamation which recovered only the silver and gold. Later concentrating tables were added to recover galena, but when the heavy sulfide ore containing much sphalerite was reached with depth, milling ceased. In describing this period Ferguson[121] reports that 42,000 tons of ore yielded 20 ounces silver and 0.12 ounces gold per ton.

Ferguson goes on to state that several unsuccessful attempts were made later to reopen the mine. The latest and of most importance was in 1917 by the Louisiana Consolidated Mining Company, with Walter E. Trent, president, who took over the property from Victor Barndt, Sr. and relatives, and erected a bulk flotation plant which closed in 1920. The high zinc content of the concentrate was a detriment as selective flotation was then unknown.

The Treadwell-Yukon Company, with the Bunker Hill and Sullivan Company carrying a 50 percent stock interest, took over extensive holdings in the camp in 1925 and after unwatering and doing considerable exploration constructed a 350-ton selective flotation concentrator which began operation on May 13, 1929. W. H. Blackburn[122] gives a detailed description of the mill and the

[120]Geology of the Tybo District, Nevada: University of Nevada Bulletin, Vol. XXVII, No. 3, August 1, 1933.

[121]Op. cit., Geology of Tybo, p. 43.

[122]Blackburn, W. H., Milling Methods and Costs at the Lead-Zinc Concentrator of the Treadwill-Yukon Company, Ltd., at Tybo, Nevada: U. S. Bureau

ore treated during the early years of operation. Couch shows the recorded production from this operation to be $6,781,405 from 465,657 tons during 1929–1937, at a period of low prices for lead and zinc. The mill was temporarily shut down during 1932–1933 and closed finally on September 30, 1937. It was removed from the property during 1937–1939. Leasing has been almost continuous since the company ceased its operation. Couch shows the total recorded production from the Tybo district from 1874 to 1944 to be $9,789,281 from 596,040 tons. Of this amount, $392,229 from 28,139 tons was produced from shipments after the mill shut down in 1937.

Geology. Nothing can be added here that is not more adequately covered by Ferguson; therefore a few of his statements[123] and a very brief summary of the geology is considered sufficient.

> The rocks include marine sediments of Cambrian, Ordovician and Silurian age, two nonmarine formations of probable Tertiary age, and dikes and lava flows also regarded as Tertiary.

The sediments are largely limestones and shales with some quartzite and chert. The dikes and lower Tertiary lava flows are porphyritic quartz-latites which are similar to the general country rock found to the north in the Morey district. Later Tertiary rhyolite flows are found in the western part of the Hot Creek area.

Ferguson also reports:

> Practically all the ore so far mined has come from bodies along the 2 G fault, principally bodies that have replaced the dikes of quartz latite porphyry which follow the fault. The primary sulphide minerals are pyrite, sphalerite, galena, chalcopyrite, pyrrhotite, and arsenopyrite. Of these only galena and sphalerite are ore minerals under present conditions. The galena is argentiferous. Nonmetallic minerals are chiefly fine-grained quartz and coarsely crystalline white calcite. Manganiferous calcite is present in a few small veins in the district.
>
> The oxidized minerals which were first mined extended to a depth of about 300 feet. Below this depth oxidation is sporadic. The higher silver content of the sulphide ores in the upper levels, as well as the presence of later pyrite and marcasite, suggest that there has been some supergene sulphide enrichment.

[123]Op. cit., Geology of Tybo, pp. 8, 11, 12.

Ferguson states that he visited the district in the summer of 1929 and spent three weeks in a preliminary study of the geology. He made a second short visit in the summer of 1930. Considering the short time spent on the ground, Ferguson presents much information and his work is an important addition to the geology of the State; however, it is hoped that further work on this area will at some future time be undertaken. He states:

> The structure of the Tybo district is complex, and the writer is by no means satisfied that in the short time available for the work he has been able to make an adequate explanation of all the facts observed.

Properties. The Tybo mine itself is now owned by Herman Budelman, Fred Ninnis, and Philip R. Bradley, Jr. of Tonopah and San Francisco, who took it over from the Treadwell-Yukon Company in about 1947. The principal workings are along the 2 G fault as practically all the ore mined has come from tabular bodies along this structure. The fault-vein has been explored for about 2,500 feet along its strike and to a depth of 1,310 feet. As per information obtained from V. J. Barndt, after Ferguson's report, the company sunk the Hales shaft from the 860-foot level to the 1,310-foot level and drifted on the 860-, 1000-, 1160-, and 1310-foot levels. In referring to the ore bodies the Hales shaft is used as reference and ore east of the Hales shaft is known as the East ore body and that west of the shaft is known as the West ore body. Barndt states that the ore raked to the east as it went down and the East ore body was stoped above the 1310-foot level. The West ore body was mined to a depth of 1,010 feet and was longer on this level than on the 860-foot level. Grab samples from a 10- to 12-foot winze on the 1010 level are reported to average 10.4 ounces silver, 6.1 percent lead, and 7.9 percent zinc per ton. It is said that the water flow at this point was heavy. An average of 138 samples on the 1,010 level gives 10.0 ounces silver, 6.6 percent lead, and 6.8 percent zinc. The last short test-hole drill samples of the east face of the 1,310 level average 3.8 ounces silver, 4.4 percent lead, and 3.7 percent zinc.

V. J. Barndt, of the original Barndt family, lives in Tybo and is the most recent lessee of the Tybo mine. He has been familiar with the area since childhood days and has the assay results of much sampling done during the latter part of the company's operation, plus many maps of the mine.

With a good State highway to the smelter at McGill, there

appears to be an opportunity to find profitable silver ore by exploring the walls in the vicinity of the old rich stopes in the oxidized zone.

The Dimick mine, owned by E. S. and V. J. Barndt, lies west of the Tybo mine workings. Little is known about the history of the property and Ferguson believes the production was probably small. In describing the ground he states:

> The lode follows the Dimick fault, which in the developed area has Pogonip limestone on the north and massive dolomite, of the Lone Mountain dolomite, on the south. Narrow dikes of sheared and brecciated porphyry occur in places along the fault plane.

The Uncle Sam fault lies between the Tybo workings and the Dimick. Ferguson states:

> It is possible that post mineral movement on the Uncle Sam fault has depressed the horizon of the ore and that exploration of the Dimick fault in depth may eventually be desirable.

Ferguson's map indicates nearly 1 mile of workings off the two shafts, about 200 feet apart. In addition to the workings mapped, an unknown footage is inaccessible.

The Swarbrick prospect, owned by the East Tybo Mining Company and controlled by W. S. Larsh of McGill, lies east of the Tybo mine on the continuation of the 2 G fault. The only reported production has been 1½ tons of sorted ore that contained 130 ounces silver and 60 percent lead per ton. Ferguson states, "The principal workings are along the 2 G fault and consist of a tunnel about 500 feet in length and several smaller tunnels and pits, which prospect the 2 G fault for a distance of about 2,000 feet westward from the point where it is cut off by the fault along the front of the range." The 500-foot adit exposes a few narrow widths of only slightly oxidized galena.

The Ramona group of six unpatented claims, owned by R. R. Redenbaugh and others, lies on the hillside north of the Tybo camp. Ferguson describes the property, "A tunnel 100 feet to the east follows for 100 feet a two-foot zone in a shattered porphyry dike. Along this zone manganese oxide, probably originally present as a carbonate, has replaced the porphyry. The strike is N. 60° E. and the dip is 70° N." It is reported that a few hundred tons of a manganiferous silver-gold ore was shipped to McGill during 1940–1941.

The A. & B. and M. & M. mercury mines are nearly adjoining properties on opposite slopes of the Hot Creek Range near its crest about 6 miles north of the Tonopah-Ely highway. The properties are owned by Lorena Peterson and the Buckley estate. The Petersons live on the M. & M. group and are presently operating it on a small scale, using two pipe-retorts. Bailey and Phoenix show a production of 250 flasks from the two groups. They state:

> Cinnabar was discovered on the crest of the Hot Creek Range in argillized rhyolite in 1929, and in 1934 J. Y. Anderson and H. Buckley discovered cinnabar float midway between Warm Springs and Tybo on the western side of the Hot Creek Range. Since that time two properties, the A. & B. and M. & M. mines, have been intermittent producers in the area.
>
> The rocks in the quicksilver-producing area consist of interbedded, flat-lying tuffs and flows of Tertiary Age.

The Ophir and Dexter, also known as the Rattlesnake mine, owned by W. L. Wiswall and others, is in the Keystone area in Rattlesnake Canyon 5 miles air line north of Tybo Canyon. This property has several old shafts up to 150 feet in depth, none of which are in operating condition, and several hundred feet of laterals. Couch shows a production of $4,789 from 239 tons shipped by the owner during 1941–1945. It is reported that the ore contains silver with tetrahedrite and no gold. The ore bodies are found in limestone.

The Dominion group of two patented and a few unpatented claims is owned by V. J. Barndt. The property is up the canyon from the Ophir and Dexter and has similar mineralization. Workings are reported to consist of two 100-foot shafts and a short adit. Barndt reportedly shipped about 300 tons from the dumps.

A building-stone quarry, 7 miles up Rattlesnake Canyon from the Wiswall property, is owned and operated by Barndt and Crouse of Tybo. In the fall of 1949 they were mining a banded rhyolite for use as building and flagstone material. The rhyolite is a fine even-grained rock difficult to distinguish from sandstone. The banding is nearly flat and occurs in shades of white, grey, pink, brown, and green.

The Uncle Sam patented and six unpatented claims, owned by Bonny Ornelas and others of Tonopah, lie on both sides of the Hot Creek canyon about 2 miles west of the Hot Creek ranch. Some work was done here in the early days of the district. During the past few years, the present owners have built two short sections of road to the workings and have done additional exploration on a north bearing shear in limestone. The ore is somewhat spotty and contains both sulfide and oxidized silver minerals. The owners report a small shipment that contained about $9 per ton in silver with some gold.

UNION (Ione, Berlin, Grantsville)

The Union district covers the area near and between Ione and Grantsville. It lies in the Shoshone Mountains, a narrow range on the west side of the Reese River Valley. The mining properties are situated at elevations ranging from 6,500 to 8,000 feet and are usually accessible by fair dirt roads. The nearest paved road is U. S. Route 50 which is about 30 miles from Ione at a point near Eastgate, and about 55 miles distant at Austin. The roads connecting Ione with the highway are improved dirt roads, ordinarily in good condition. Weather conditions will usually allow year-around work, although some properties may be temporarily inaccessible due to drifting snows. Water for domestic purposes is readily available in most of the district; however, enough water for milling can be found in only a few places.

Ore was discovered in the Union district in 1863 by P. A. Haven. The district was subsequently organized, and the towns of Ione and Grantsville were established. Nye County was separated from Esmeralda in 1864 upon petition by the miners of the community, and Ione was designated as the first county seat. Two mills were built to treat the gold and silver ores of the district. The Pioneer, a 5-stamp mill on the lower outskirts of Ione, was apparently to be used on ores originating at Ione; however, it appears that it ran very little until the latter part of the century when it was used for Berlin ore. The Knickerbocker mill, with 20 stamps and 6 roasting furnaces, was located about 1 mile south of Ione and treated the Grantsville ore until 1869 when the activity of the district temporarily subsided. In 1867 the county seat was moved from Ione to Belmont. This, coupled with the decrease in mining activity, was a hard blow to the community. Grantsville again came to life in 1878 and, as per Thompson and West, had a population of 800 and listed 42 business establishments including a brewery and newspaper. The Union district has had an intermittent production from the gold, silver, and lead mines since those early days. Mercury was discovered near Ione in 1907 and as per Bailey and Phoenix, 10,000 flasks were produced prior to 1920. Since that year, the production has been about 50 flasks annually.

Geology. Information from Muller and Ferguson[124] lists Carboniferous volcanics as the oldest rocks in the district. The Berlin mine and part of the Richmond, 1 mile east of Berlin, are in this formation, which is commonly referred to as meta-andesite or greenstone. These old volcanics are overlain by a Triassic series of slates, conglomerates and limestones. The Grantsville mine and part of the Richmond are in this later formation. The sedimentaries have been intruded by an aplite near Grantsville and by a small granodiorite stock 1 mile south of Ione. Small exposures of the granodioirte were found northeast of the Knickerbocker tailings. The latest formations are Tertiary flows of rhyolite and andesite with which are associated the mercury deposits southeast of Ione and the high-grade stringer gold deposits northwest and northeast of Ione. The Tertiary lavas are found on the east side of the range for the full length of the district and extend to the west side near Ione and at Grantsville. The high-grade gold stringers northwest of Ione have fed nearby placer gravels that have been worked intermittently since about 1909. Although silver, gold and mercury have been the principal economic metals of the district, the Alexander mine at Grantsville has produced large quantities of lead, copper, and zinc.

The Shamrock mine is 1 mile southeast of Ione at an elevation of about 7,500 feet. It is comprised of several unpatented and eleven patented claims, including the Indianapolis which has a production record dating back to 1867. Since 1888, production has been small and intermittent, being made principally by lessees. Total recorded production is $107,000. A cyanide mill constructed in Ione in 1924, was changed to a table concentrator in 1929; however, a 17-ton trial run is reported to have been the total ore milled. The mill building still stands, nearly all equipment having been since removed. The mine and mill building are owned by the Shamrock Mines Company of Salt Lake City, Utah.

The Shamrock ore occurs in a narrow band usually under 18 inches wide in about 4 feet of quartz in Tertiary andesite. Values are principally silver, the silver to gold ratio being approximately 400 to 1 by weight. The vein strikes northwest and has been explored intermittently for several thousand feet. Production has been principally from the Indianapolis claim which has a 200-foot inclined shaft with about 1,000 feet of laterals. As stopes have been gobbed with waste, it is difficult to estimate the actual

[124]Ferguson, H. G. and Muller, S. W., Structural Geology of the Hawthorne and Tonopah Quadrangles, Nevada: U. S. Geol. Survey Prof. Paper 216, Plate 13, 1949.

amount of mining done. Several shafts have been sunk along the vein northwest and downhill from the Indianapolis, the lowest important opening being an adit on the Crown claim having about 2,000 feet of workings. George Bond and James Ford of Ione, have done much of the recent leasing on the Shamrock and are very familiar with the workings.

The North Star patented claim, also known as the Phillips mine, is a fraction in the Shamrock group of patented claims near their southeast end. The property is owned by Mrs. J. C. Phillips of Reno and C. L. Stephenson of Los Angeles. A 300-foot shaft on the North Star claim caved to within 50 feet of the surface during the earthquake of 1932, making the workings only accessible through the Indianapolis shaft on the Shamrock ground. Although Phillips made a living off this property for many years, shipments were probably small and no production is recorded. The ore is the continuation of the vein on the Indianapolis and is reported to be from 4 inches to 2 feet wide, averaging about $22, principally in silver. Like the adjoining property, the vein occurs in Tertiary andesite. Besides the caved shaft, the North Star has two other shafts, one 50 feet deep and the other 100 feet deep. The latter, equipped with a hoist and headframe, is near the old caved shaft and was sunk by lessees who are reported to have shipped ore during World War II.

The Bald Mountain Bill property, also known as the Black Diamond or Brown Derby, is about 1 mile northwest of Ione on the southern slope of a bulge in the Shoshone Range. The claims were originally located about 1907 by J. N. Bryant and later abandoned. In the late twenties they were relocated by Bill Culver, from whom the property obtained its name. In 1941 the claims were purchased by the original locator, Bryant, who is the present owner and lives in Reno. A little gold production has been made from high-grade stringers and pockets, which occur in Tertiary rhyolite and are usually associated with jasper. Undoubtedly the weathering of these high-grade stringers are the source of the gold placers lying adjacent to and below the property. As is so common with bunchy high-grade occurrences of this type, most of the work has been done in several relatively shallow shafts, the most recent of which is equipped with a good headframe. The work also includes an 80-foot drift-adit.

The Gold Nuggett Placer group of 11 claims, containing 1,760 acres, lies below the rhyolite gold deposits northwest of Ione. The ground was located in 1948 and 1949 by Joe and Frank Bastian of Round Mountain, and William B. Pate of Tonopah, who

sunk several test holes 35 to 90 feet in depth. No large boulders were found in the test holes.

That part of the placer lying north of the Ione road, and nearer the stringers of gold ore in the rhyolite, was recently tested.[125] An area 300 feet by 2,400 feet to a depth of about 1 foot averaged $1.25 per cubic yard. A caliche is found at this depth and acts as a false bedrock for the better-grade gravel. A test was made on a well in Ione Canyon during which 100 gallons per minute was pumped for 3 hours with no noticeable lowering of the water table, thus indicating available sluicing water.

The Ward mine is in and near Becker Canyon on the east side of the Shoshone Range, about 5 miles west of State Route No. 21 and 11 miles northwest of the Reese River Ranger Station. It is at an estimated elevation of 7,500 feet. Gold mineralization was discovered on the property in 1906 by J. M. Ward and, after being abandoned and relocated several times, the group of six claims now belongs to Arthur J. Ward of Reese River and T. W. Johnson of Los Angeles. The only production has been $3,800 in gold and silver, recovered from 200 tons milled on the property in a small Straub mill during 1935–1940. The ore occurs in narrow seams of shear zones in Tertiary rhyolite. The seams average only a few inches in width and often occur in near enough proximity to allow two or more to be mined together. At the south end of the group, 600 feet of drifting has been done in eight adits on the shear zones. At the north end, about 100 feet of work has been done in two adits on what appears to be a wide low-grade zone. Here the seams are more frequent and it is reported that a 20-foot width assays $6.60 in gold and silver. It appears that the best possibilities for the property lie in the development of a large low-grade deposit. Improvements consist of a sheet iron compressor building and a 3-room house. Becker Canyon has sufficient water for about a 200-ton mill.

The Copper King group, located in 1939 by Harold P. Newman of Ione, is on the west slope of the Shoshone Mountains at an elevation of about 7,500 feet and about 4 miles south of Ione by road. Minor old workings on the property indicate that it was first discovered during the early days of the district. The valuable minerals are those of copper occurring as sulfides and carbonates in east-west shear zones in Triassic schists, slates, and quartzites. A faulted segment of granodiorite about 50 feet wide was found within a few hundred feet of the working. The ore zones are exposed for widths of only a few feet, further exploration being

[125]Personal interview with F. D. Shuck, Glendora, California.

necessary to determine the full extent of the copper mineralization. As the ore appears to be of good grade in the zones as exposed, further exploration may find ore bodies of economic size. Workings consist of an old 45-foot inclined shaft, a 120-foot adit and several open cuts. In 1948, 2 miles of road were built with a bulldozer and the owner plans to build another one-half mile which will complete the road to the workings.

The Berlin mine lies on the west slope of the Shoshone Mountains at an elevation of 7,000 feet, about 5 miles south of Ione. The property is owned by the Nevada Company of which J. G. Phelps Stokes of New York is president and J. M. Hiskey of Reno is manager. The mine was purchased by the Nevada Company in 1898 from Bell and Bray, who are reported to have produced about $72,000 from the milling of an estimated 6,000 tons of gold and silver ore at the Pioneer and Knickerbocker mills near Ione. Shortly after the transaction, the mills were moved to Berlin and additions made to increase the size to 30 stamps; ore treatment was by amalgamation and vanner concentration. In 1908 the property was sold under a mortgage arrangement to the Goldfield Blue Bell Company and in the following year the mill was shut down. Apparently the requirements of the agreement were not met as the Nevada Company foreclosed in 1928.

During the last Berlin mining operations, in 1909, good grade ore was mined to the side line of the property. The Nevada Company purchased the adjoining claim and in 1948 an attempt was made to get into the old workings. The Diana adit was extended 900 feet and an inclined winze connection made with an old partly caved exploratory lateral of the 4th level off the Berlin shaft. However, after working through about 900 feet of this lateral, heavily caved ground was encountered near the old stopes and the work was abandoned. In 1938, and again in 1948, the company also did some surface bulldozer exploration. Some underground exploration was done in 1950. Reported Berlin production is $849,000 recovered from about 85,000 tons, giving an average yield of $10 per ton of ore.

The Berlin ore occurs as a quartz vein filling, usually 2 to 3 feet wide in Permian(?) meta-andesites often referred to as greenstones. As per Daggett,[126] the ore is extensively faulted in two directions, making segments terminated on all sides by fault planes. The vein segments strike northeast and dip at an average of 45° SE.; they are believed to be parts of more than one vein.

[126]Daggett, E., Extraordinary Faulting at the Berlin Mine, Nevada: Trans. A. I. M. E. 1907, pp. 297-309, 1908.

The sulfide content of the ore is reported to be about 2 percent, containing sulfides of iron, copper, lead, zinc, and antimony.

The Berlin mine was worked from an inclined shaft, with eight levels, to a vertical depth of about 360 feet. Most of the workings are now inaccessible. Although the mine has about 3 miles of laterals, which is considerable for the amount of ore removed, the maps indicate large virgin areas that may, with proper geologic guidance, be found to have segments of commercial ore.

Berlin improvements consist of a camp with several good buildings, including the mill building, and a water supply sufficient for a small mill. The mill was stripped of stamps and other equipment during World War II.

Mr. A. M. Smith of Carson City reports that during the years 1911–1914 he operated a 50-ton per day cyanide leaching plant on the Berlin tailings. He states that he worked 6 months out of the year and averaged 35 to 40 tons per day. The tailings contained $2.25 to $2.65 per ton and he recovered about 80 percent of the values. Water for the plant was piped from Knickerbocker Springs 6 miles distant.

What is commonly known as the Bowler mine, but part of the Berlin property, is less than 1 mile north of the Berlin camp. Here, flatly lying veins of 2 to 3-foot width have been extensively worked from an adit and shallow shafts having several hundred feet of total workings. All openings are accessible, although no work has been done in recent years. The ore occurrence is like that at the Berlin.

The Richmond mine is situated in Union Canyon, about 2 miles southeast of Berlin, at an elevation of 7,400 feet. Sufficient water for milling purposes may be obtained in this canyon, about 1 mile below the mine. The property is part of the Nevada Company holdings in the area. Although Union Canyon was probably settled in 1864, the same time as Grantsville and Ione, little is known regarding the early work at the Richmond mine. During the last 40 years, all the work has probably been done by lessees who shipped an estimated $30,000 of ore. Since 1945, the mine has been under lease to Harold P. Newman who installed a 15-ton capacity gravity-concentration and flotation mill about 1 mile below the mine in 1948. The Richmond ore occurs as a fissure quartz vein in both Permian(?) greenstone and Triassic calcareous sediments. The ore minerals are tetrahedrite and galena which are found associated with pyrite and although most of the ore has come from near the surface relatively little oxidation has taken place. The vein is faulted in segments much the same as the Berlin except that not enough work has been done to determine the frequency of the faulting. The ore is from 1 to 4 feet wide and occurs in shoots which are reported to assay from $30 to $60 per ton. Although the Richmond has about 2,000 feet of workings, less than half of this is on the ore. From recent work done on the property it appears that careful geologic mapping, coupled with a little trenching, could trace more of the vein on the surface at relatively little cost.

The Doonan property, a gold prospect owned by Mrs. Albin L. Nelson of Gabbs, is situated about 1 mile northeast of Berlin at an elevation of 7,500 feet. It is said to have a 75-foot inclined shaft and a 50-foot trench on two veins. No production has been made from the property. Improvements consist of a cabin in good condition.

The Grantsville mine, also known as the Alexander and Brooklyn or Silver Palace, is owned by E. H. Berryman and B. Cisilini of Gabbs and Ione, respectively. A 50-ton Diesel operated flotation mill on the property is owned by Ira L. Kent of Fallon. The property is at 6,900 feet elevation and lies about 10 miles by fair road south of Ione. Water is obtained from the mine workings, although recent diamond drilling encountered a flow of water just south of the camp.

Thompson and West credit P. A. Haven with the discovery of the mine in 1863. At that time the property was known as the Great Eastern. It is reported that the Knickerbocker mill, the foundations of which may be seen 2 miles south of Ione, was built to treat the Great Eastern ore. This mill operated from 1864 to 1869. Whitehill[127] states that in 1877 the claims were relocated by P. Lefler and sold to Manuel San Pedro and others, who patented the claims and organized the Alexander Company. A 20-stamp mill was built at the mine and began operation in 1878. Thompson and West state that the mill was enlarged to 40-stamps in 1880 and the following year the camp had 800 inhabitants and 42 business houses, including a newspaper and a brewery. News items[128] state that the total operating cost in 1880 was $9 per ton. The following year the property was sold for $572,000 and in the early 1900's the mine changed hands several times. Couch shows the recorded early day production, from 1866 to 1891, as $1,208,632 from 37,988 tons.

[127] Whitehill, H. R., 7th State Mineralogists Report, 1878.
[128] Engineering and Mining Journal (clipping file in Bureau office.)

Mineral Resources (1922) reports that the Webster Mines Corporation, an association of W. J. Webster with Seeley Mudd operated the mine for a short time. John Burgess pumped out the Alexander shaft and made a complete examination of the mine at that time.

Later in the twenties, Jay A. Carpenter, in partnership with a Mr. Bray, operated the mine for a few months. The oxidized ore from the upper levels, which had a higher silver content, was treated in a cyanide leaching plant. Mr. Carpenter then sold out to Mr. Bray who converted the mill to flotation and mined sulfide ore from below the main adit level. The property was then idle for several years, during which time the present owners purchasd the claims at tax sale.

In 1939–1940, W. J. Barrows, operating as the Silver Palace Mines, installed a 50-ton flotation mill, which is now on the property, and treated 12,233 tons of ore during the latter nine months of 1941. Making a bulk concentrate, containing silver, lead, zinc, and copper, this company produced about $100,000. The property was shut down and, in 1942, Ira Kent of Fallon took over the mill for outstanding bills. He operated for a short time and was followed by the Rex Mining and Milling Company of Reno. No record of production was found for either of the latter two operations.

The Alexander and Brooklyn Mines Company, with E. D. Feldman as president and Clyde Collins of Carson City as consulting engineer, began operations in 1945 and, as per information obtainable, received about $50,000 from concentrates to the middle of 1947. Data of three months operation in 1947 show 4,450 tons milled, containing 5.15 ounces silver, 0.80 percent lead, and 1.87 percent zinc per ton. Fifty-five tons of concentrates produced averaged 308 ounces silver, 42 percent lead, and 12 percent zinc per ton. During this period, mill extraction averaged 76 percent for silver and 72 percent for lead. Silver extraction dropped during the latter part of this period and it is understood that the operation was running without adequate supplies. All this ore, except 193 tons mined underground, came from dumps. The sulfide ore on the lower levels is extremely hard and the ore which was mined from development headings cost $26 per ton. Little actual stoping was done.

The ore occurs as replacements in triassic limestone. The bodies are irregular and sometimes as much as 50 feet wide. The division between the oxidized and sulfide ores is approximately at the lower or fifth adit level. In some areas the sulfide ores contain considerable zinc, especially at greater depths. Some dumps show much scheelite and high-grade specimens have been found; however, recent sampling showed the best rock to contain 0.2 percent WO_3.

The workings consist of five adits connected with a vertical shaft having three levels 50 feet apart below the lower adit. The last underground work was done on the lower levels, below the water table. These workings were unwatered in 1949 by the Coronado Copper and Zinc Company (the Mudd interests) which made a complete examination of the mine and also did some reconnaissance diamond drilling in the area.

The workings mentioned, total over 1 mile and are sometimes referred to as the Alexander. Across the canyon is an inclined shaft, with considerable work, now partly filled with tailings. This shaft is known as the Brooklyn. It is believed that little or no work has been done here for many years.

The camp has several buildings in good condition and machinery facilities for mining are about as they were during the last operation. A well was developed by the diamond drilling near the camp and may be expected to help the water supply in the event of future operation.

The Coronado Copper and Zinc Company of Los Angeles; Mr. Benjamin H. Sheahan of Reno, the engineer in charge of operations for the Alexander and Brooklyn Mines; and Mr. Clyde Collins of Carson City, are probably the most familiar with the potentialities of the Grantsville property.

A fluorite prospect located in 1941 as the Allied group by Roy C. Ames of Ione, is situated 1½ miles southerly of Grantsville, between Grantsville and Milton Canyons. Twenty-nine tons of acid grade ore was shipped by a lessee in 1948. The area has been classified by Muller and Ferguson as Triassic dolomite. Pockets and bunches of fluorite occurring along a shear in a silicified zone have been opened by minor surface workings. The best exposures are in two pits, one 15 feet long and 5 feet deep on 4 feet of fluorite, and another 6 feet long and 8 feet deep on 3 feet of fluorite.

Another fluorite property, owned by L. E. Murray of Grantsville, adjoins the north end of the Ames ground and extends northwesterly along the ridge toward Grantsville. Discovery has only recently been made, and cuts and trenches expose the mineral.

An antimony prospect in Milton Canyon 2½ miles south of

Grantsville, consisting partly of patented claims, is owned by E. H. Berryman of Gabbs. The ore occurs as stibnite somewhat disseminated in a silicified zone of limestone which may be the continuation of the same zone of silicification noted on the Ames fluorite property about 1 mile to the north. A 20-foot shaft and several trenches are the only workings. John Heizer of Lovelock thoroughly sampled the ground during the summer of 1948. An attempt to diamond drill the ground was made at the same time but, after the drilling of two short holes at excessive cost, the drilling was abandoned.

A prospect owned by L. E. Murray of Grantsville, is situated one-half mile north of the camp at an elevation of 7,400 feet. The ore is reported to occur in a 30-inch vein between limestone and andesite. A sample, representing sorted ore, assayed 0.28 ounces gold, 4 ounces silver, and 6.5 percent copper. The workings consist of a 25-foot shaft and 20-foot adit.

Mercury Properties. Edgar H. Bailey and David A. Phoenix in their bulletin, Quicksilver Deposits in Nevada, published by the Bureau in 1944, give detailed information on the mercury deposits; therefore, nearly all data on these properties have been taken from their report.

The Mercury Mining Company mine, owned by the J. C. Bradley Mining Company of San Francisco, is at the head of Shamrock Canyon 2½ miles by road southeast of Ione, at an elevation of 7,800 feet. The deposit was discovered in 1907 by J. L. Workman and purchased by the Bradley Company in 1923. Total production is 7,290 flasks of mercury and, except for recent years, 40 to 50 flasks have been produced annually since 1925 by various lessees. Its only rival for total production has been the Cordero mine in northern Humboldt County, opened 20 years later. The rocks in the area are Triassic calcareous shales with some limestone intruded by and faulted against Tertiary volcanics, principally rhyolites. The mercury occurs as cinnabar, the main ore bodies being found in the folded and faulted calcareous shales near two parallel and nearly vertical faults. The workings consist of four large glory holes from which the only ore bodies of appreciable size were mined, connecting adits having a total of 3,400 feet of laterals, and several smaller pits and minor workings. The large ore bodies apparently bottom in the glory holes and the underground exploration indicates no others. The camp is situated at a spring and is reported to have one house in fair condition.

The Nevada Cinnabar mine, formerly known as the Shoshone Quicksilver mine, is situated at the head of Sheep Canyon near the crest of the Shoshone Range at an elevation of 7,800 feet. The mine is about 5 miles by road southeast of Ione. The property is owned by Mrs. B. Cislini of Ione and the estates of S. Lompa and J. M. Doonan. Discovered in 1907, the deposit was purchased by the Nevada Cinnabar Company of Salt Lake City in 1912 and produced 3,462 flasks of mercury, from 1914 to 1918, in a 50-ton Scott furnace erected by the company. The mine has been idle since then, except for the period of high mercury market during World War II when lessees treated hand-sorted ore in a 2-pipe retort. Total production has been about 4,200 flasks of mercury. Tertiary volcanics, principally pyroclastics, make up the rocks in the area. The youngest unit, a dacite flow, is in fault contact with a partially silicified rhyolite agglomerate in which the ore occurs. The fault strikes northwest and dips about 45° SW. The only known ore body was mined from the rhyolite agglomerate beneath the fault and occurred in a series of fractures roughly paralleling the fault. The ore was mined by two large glory holes, tapped by adits having a total length of 750 feet. In addition, a large number of shallow pits have been dug along the northwestern extension of the fault, and two short prospect adits have been driven across the canyon from the fault. It appears that further exploration along the southeastern extension of the fault is justified. It is reported that some processing equipment and several buildings remain on the property.

The Two Injun mercury prospect, discovered in 1940 by the present owners, Ben and Trueman Collins, lies about 1 mile west of the Mercury Mining Company mine in a small southerly tributary to Sheep Canyon. Although the owners erected a single pipe retort, the property has no known production. Cinnabar occurs as dissemenated crystals in the gouge of a northerly trending fault zone in silicified limestone and conglomerate. Exploration consists of several scattered trenches.

The Yellow Cat mine, also known as the Golden Fleece, is a small mercury mine at the head of Shamrock Canyon about one-half mile north of the Mercury Mining Company mine. It is owned by John Connolly of Tonopah and reportedly a small production has been made by lessees. Cinnabar occurs in high-grade veinlets and lenses in an irregular northerly trending shear zone in Triassic interbedded shales and limestones. Exploration consists of a shallow shaft with about 150 feet of laterals.

The San Pedro mercury mine, owned by H. R. and Ella Humphrey, S. Chiatovich, and E. J. Shirley, is on the summit of the

Reese River—Grantsville pass at an elevation of 7,600 feet. The property was discovered in 1941 and later worked by lessees who produced about 42 flasks of mercury. The cinnabar occurs in a tuff containing boulders of rhyolite, conglomerate, argillite, and other rock types; it is overlain by rhyolite and andesite flows. A 50-foot vertical shaft in the tuff exposes ore that is reported to average 12 pounds of mercury per ton near the surface, but only about 4 pounds per ton at the bottom. Several power shovel trenches aggregating about 800 feet in length, dug in the vicinity of the shaft, failed to expose the continuation of the ore. No local control for the ore was found and it is suggested that it may be an old fumarolic vent.

WAHMONIE

The principal part of the Wahmonie district lies about 50 miles by road east of Beatty, or 20 miles northeast of Lathrop Well on the Beatty-Las Vegas highway. The nearest water is Cane Spring, about 5 miles southeast. Principal past activity has been in an area of slight relief at an elevation of about 4,500 feet.

The Horn Silver mine is mentioned by Sydney H. Ball; therefore, exploration here was prior to his field work in 1905. The district was rediscovered in the twenties, and a strike of high-grade silver-gold ore, by McRea and Lefler in 1928, caused considerable excitement. Engineering and Mining Journal of that time carried an article stating that about 3 weeks after the strike the camp had a population of 200, and more were arriving daily. The Wingfield interests sank a 500-foot shaft here; however, only minor ore shipments were made from the area.

Geology. Early Tertiary intrusives, largely monzonite porphyry, and later basalt flows are shown by Ball to be the principal rocks in the immediate vicinity of the old camp of Wahmonie. Rhyolite intrusions are found locally in the granitic porphyry. Farther south on both sides of the highway, Cambrian limestone and quartzite, classified by Ball as Prospect Mountain formations, are the only rocks in evidence. Mineral deposits here are found associated with shear zones in the sediments. One copper prospect and several occurrences of travertine were noted in this area. Along one northerly trending shear near the south end of the Spector Range the mineralizing activity is still in progress. A small hole in the rock is presently emitting warm water vapor.

Properties. Nothing is known about the old Horn Silver mine mentioned by Ball. He merely notes its presence and shows it on his map. The position on the map indicates it to be within 2

The Wahmonie property is now held by location as the Sylvanite group by Clinton M. Du Bois of Los Angeles. Little has been done here since the sinking of the 500-foot shaft and all surface structures have long since been removed. The owner states that some $32 ore was found on the 65-foot level.

About 12 miles east of Lathrop Well is a northerly trending belt of travertine occurring in Cambrian limestone. About one-half mile north of the highway, Walter Dane of North Las Vegas and Frank Beam of Tonopah have done some open-cut work along a well-exposed vein of travertine, 4 or 5 feet wide. They have a small cabin in good condition on the property.

Another travertine deposit on this same general belt lies about 2 miles south of the highway. The material, here exposed in cuts, is about 5 feet wide. There is no record of shipment from either of the properties in this area.

The Lucky group, a copper prospect about 3 miles east of Lathrop Well and 1 mile north of the highway, was discovered by Claude Looney in 1946. The copper occurs largely as the carbonate in an easterly shear zone in quartzite traceable for about 500 feet and having an average width of 1 to 4 feet on the surface. Early in 1950, Tom Beard of Las Vegas had several men working here driving a drift-adit which was then in 140 feet. A trial shipment of the ore had been made but returns had not yet been received.

WASHINGTON (San Juan Canyon)

The Washington district covers a small part of the Reese River side of the Toiyabe Range bordering Lander County. It is about 10 miles from the Reese River by rather poor road and from this point is an equal distance from U. S. Route 50 by improved dirt road. Hill[129] states that discoveries of silver ore were made in 1862 and 1863, but that only minor work was done in the early days as the base character and the low grade of the ore made its mining uneconomical at that time. San Pedro Canyon, now known as Washington Canyon, and San Juan Canyon to the south, a branch off Cottonwood Canyon, are the only areas of appreciable activity. Some silver ore was shipped from Washington Canyon in 1918–1919 and lead ore shipments were made from San Juan Canyon during the summer of 1948. Production from the district has been only minor.

Geology. As indicated by Hill,[130] this area of the Toiyabe Range is made up of Cambrian(?) quartzites, Silurian shales and

[129] Hill, James M., Some Mining Districts in Northeastern California and Northwestern Nevada: U. S. Geol. Survey Bull. 594, p. 120, 1915.

schists, and Carboniferous limestones. These Paleozoics are intruded by Cretacious or Tertiary(?) granodiorite which outcrops on the east side and near the crest of the range in contact with the quartzite. The lower elevations on the west side of the range, particularly south of San Juan Canyon, are covered with Tertiary rhyolite flows. Ores in the district usually occur in the calcareous shales which are often interstratified with limestones. Ore minerals commonly found are arengtiferous galena and tetrahedrite, sphalerite, and stibnite, with which pyrite and arsenopyrite are often associated.

Properties. The Warner mine lies on the ridge between Washington (formerly San Pedro) Canyon and Cottonwood Canyon on the Reese River side of the Toiyabe Range at an estimated elevation of 8,500 feet. The property is owned by the estate of Mrs. Rose Warner (Werner) of England. Weed (1926) states that the earliest work was in 1860. Neipold Werner operated the property until his death in 1910. His widow then continued the work and it is reported some ore shipments were made in 1918–1919: however, no production has been recorded. In 1922 the Warner Mining and Milling Company purchased the mine and installed a small gravity concentrator in Washington Creek with a 1500-foot aerial tram from the mine. The mill proved unsuccessful, operating only a very short time. The claims were later abandoned and relocated by Mrs. Warner who had the annual assessment work done when required. The ore contains silver, lead, copper, and antimony occurring in shear zones in the Paleozoic calcareous shales and quartzites near a small granodiorite outcrop. The development consists of an adit with about 500 feet of workings near the head of the tram, and several minor excavations. All improvements, except part of the tramway cable, have been removed from the claims. William M. Thacher of Austin looks after the interests of the Warner estate and is familiar with the property. Clyde Collins, of Carson City, examined the claims in 1947.

The Grand View group of four claims, owned by Clyde and Earl Merkt and Louis McGruder, all of Fallon, is situated in San Juan Canyon about 11 miles east of the Reese River and 5 miles above the fork of San Juan Creek off Cottonwood Creek. The elevation at the property is about 8,200 feet, and winter weather conditions often make it difficult to work more than 6 or 7 months out of the year. Water is plentiful for any milling operation that may be reasonably contemplated. Discovery of the lead-silver deposit

was made by the owners in 1947. During that and the following summer, they shipped 83 tons of selectively mined ore that grossed about $11,000. The ore occurs in veins and mineralized cross-fractures having a general northeast strike and dipping nearly vertically. Although much of the ore is highly oxidized, unaltered galena is common in the outcrop which can be traced for several hundred feet on the surface. The principal mineralization occurred in Silurian calcareous shales, although thin limestone beds nearby contain minor amounts of silver minerals. Ore widths average about 14 inches and all mining is done selectively. Two drift-adits, one 25 feet above the other and totaling 500 feet of work; a 105-foot inclined shaft; and several small trenches trace the mineralization for about 600 feet. Very little stoping has been done on the property, nearly all ore having come from exploratory drifting and sinking. All workings are in accessible condition and the property is being actively explored by the owners. Improvements consist of track and car, a Gordon Smith-type compressor, and a well-built cabin.

The St. Elena patented claim, owned by Mrs. Clara Williams of Berkeley, California, is one of the old narrow claims. It is 200 feet wide and 3,200 feet long and, therefore, was located prior to 1872, the year our present size of claim was established. This property adjoins the south and east lines of the Grand View group. It is reported that little work has been done here since 1876 and, as the old workings are caved, very little information on the property is obtainable. The workings are said to consist of a 113-foot vertical shaft and three adits. The size of the dump at the shaft suggests about 500 feet of workings. The country rock here is shale in which veins of lead-silver ore, similar to the adjoining claims, is found. Several sacks of ore were on the dump a few years ago but have since been removed.

The old workings in San Juan Canyon, mentioned by Hill,[131] have been relocated as the Bi-Metallic group by S. H. Linka of Austin. The farthest upstream are the more important, being known as the St. Louis and Richmond on the north side of the canyon, and the Henry George, principally on the south side. Locally the group was also known as the McIntyre mine. The claims adjoin the east end of the Grand View group and are at an estimated elevation of 8,500 feet. A narrow vein, approximately paralleling the canyon, has been explored in a 400-foot

[131] Op. cit., U. S. Geol. Survey Bull. 594, pp. 124-125.

adit on the north side of the canyon. The ore is similar to that on the Grand View and may be a continuation of the same mineralization. The ore is banded with sulfides of galena, pyrite, and sphalerite; and occurs as a quartz vein in Silurian(?) interstratified shales and limestones. A vein 3–9 feet wide, having a north strike and dipping 50° E., was also encountered in the adit. This vein crosses the canyon to the south and here is further exposed in a 180-foot adit with a winze. A high-grade streak, 9–24 inches wide, occurs in the vein and where sampled in the winze is reported to assay 28 percent lead, 19 percent zinc, and 10.1 ounces silver. A shipment of 18 tons, including ore from the winze and the dump of a caved adit, assayed 15.4 percent lead, 11.2 percent zinc, 17.5 ounces silver, and 2 percent arsenic. An open cut on another northerly striking vein, 5 or 6 feet wide and dipping 50 W., is reported to contain lead-silver ore of commercial value. All ore occurrences in this area are partly oxidized, the amount of oxidation depending entirely upon local brecciation. Improvements consist of a cabin in good condition at the end of the San Juan Canyon road.

The old Tiger workings, relocated by Linka as the Bi-Metallic No. 3, are about 1½ miles downstream, on the north side of the canyon. Much work had been done here on a narrow vein reported to be faulted. A 40-foot inclined shaft is still open but a 300-foot adit that connected with this shaft is caved. The adit apparently cut a dark siliceous shale which makes up the dump alongside the road. On the ridge to the north, a 35-foot inclined shaft has been sunk on a 9–11-foot vein having a 10-inch ore streak. It is reported that an 8-ton ore pile here assays 24.2 percent lead, 7.8 ounces silver, and 0.10 ounces gold.

The Jim Dandy prospect is about one-half mile northeast of the fork of San Juan Creek at an estimated elevation of 7,500 feet. Water is obtained at San Juan Creek. The property was originally discovered in 1923 and was relocated in 1948 by Jess Winter and Frank Vierra of Sparks, and Bart O'Toole of Reese River. No production has been made in the past; however, ore obtained from recent exploration has been stock piled for shipment. The ore contains lead with gold and silver in quartz occurring in Carboniferous limestone near its west contact with a Tertiary rhyolite flow. The ore is nearly completely oxidized and is found to be quite bunchy in the inclined shaft which the owners have recently started sinking.

An antimony prospect, recently located by William O'Toole of Reese River, is about one-half mile north of the fork of San Juan Creek and the same distance west of the Jim Dandy prospect. Sporadic stringers of stibnite in the Tertiary rhyolite can be traced for several hundred feet. Only minor surface work has been done.

WELLINGTON (Jamestown, O'Briens)

The Wellington mining district is situated in low hills in the southwestern part of the Cactus Range, about 12 miles south of Cactus Springs. The southwestern portion of the district, known as Jamestown, is on the road between Antelope Springs and Goldfield by way of Stonewall Flat. The district is on the boundary of the Tonopah Bombing and Gunnery Range, most of it being inside; however, the Jamestown workings are cut by the line.

Although no production is of record, some small shipments are said to have been made. The first claims were located here in 1904.

Geology. The areal geology is similar to that of the Cactus Springs district, adjoining on the north; and the Antelope Springs district, adjoining on the northeast. Tertiary volcanics, principally rhyolite, cover most of the area and are intruded by later andesite. An older diorite is exposed at the higher elevations in the northeastern part of the district.

The ore, with its values in gold and silver, occurs in quartz veins[132] in kaolinized and silicfied rhyolite and diorite. Fault movement and brecciation have been both premineral and postmineral. Oxidized ores show much limonite, while considerable pyrite is found in the ore and some adjoining country rock below the water table.

Properties. The Franz Hammel mine, located by Franz Hammel and Anthony Carlone of Las Vegas, is situated on the road to Stonewall Flat and Goldfield, at what is known as Jamestown. An east-west boundary of the Tonopah Bombing and Gunnery Range passes through the claims just north of the principal workings and camp. The roads to the property pass through the Range.

Small ore shipments are said to have been made from here in the past; however, it appears that no appreciable amount of work has been done in recent years.

The ore contains gold and silver and occurs in brecciated and silicified rhyolite near andesite. Ore found on the dump of the 240-foot vertical shaft contains much pyrite and was taken from below the water level in the shaft.

In addition to the main shaft, which has several hundred feet

of laterals, other shallow shafts have been sunk on the quartz veins. A dump sample of ore piled at a 35-foot inclined shaft contained 17 ounces silver and 0.08 ounce gold per ton.

The camp consists of a small cabin in fair condition, showing signs of intermittent occupancy.

The Surprise group of claims is owned by Dr. F. B. Wheelwright of Boulder City. They lie about 2½ miles southwest of Antelope Peak and 5½ miles northeast of Jamestown, at an elevation of approximately 6,500 feet. It is said that about 100 tons of ore has been shipped from the group; however, there are no records to indicate the value of the ore.

Quartz veins and stringers carrying gold and silver values are found in a diorite intrusive overlain by rhyolite flows in much of the area. The veins have been explored by two shafts reported to be of 100-foot and 30-foot depth. In addition, the workings include several open cuts and trenches.

The Golden Chariot group of patented claims, owned by Carl Fuetch of Reno, lies southeast of the Franz Hammel ground at Jamestown. Gold and silver ore with some copper occurs sporadically in quartz veins in rhyolite. The ore is bunchy but is often high grade. It is said that a few tons of ore, valued at about $200 per ton, was shipped from here in about 1908. A 300-foot shaft on the ground is equipped with a headframe and hoist. It is believed that no work has been done here in many years. The property is outside the present boundaries of the Tonopah Bombing and Gunnery Range.

The Mohawk, Daisy, and Last Chance patented claims, owned by Engrace La Barthe of San Francisco, are reported to be in this same area. The mineral occurrence is similar to the other properties in the Jamestown vicinity. Workings are said to include a 200-foot shaft, but the ground has been inactive for many years. It is outside the Tonopah Bombing and Gunnery Range.

WILLOW CREEK (Nyala, Quinn Canyon, Sharp)

The Willow Creek mining district lies about 95 miles east of Tonopah at the lower elevations of the northwest part of the Quinn Canyon mountains. The route from Tonopah is paved for the 50 miles of the Ely highway to Warm Springs; from here it is 40 miles by improved dirt road to Nyala, a ranch formerly known as Mormon Well which, in turn, is 2–5 miles northwest of the various mining properties. The claims are at elevations ranging from 7,000 to 7,500 feet. Water is obtained from a group of springs about 1 mile above the mouth of Willow Creek canyon.

As per James M. Hill in U. S. Geological Survey bulletin 648, the first discovery in the district was in June 1911 by Charles Sampson and David Jenkins. The Rustler, since patented, and other claims located by these men, were purchased by George Wingfield in 1913. Hill reports a production of 40 tons containing $8 in gold and $65 in silver per ton. Considerable excitement was caused by a strike made by Steve J. Pappas and William E. Blackwell in April 1913. It is stated that a 500-pound shipment of high-grade, made in October 1913, returned $39.40 per pound. This property was known as the Melbourn group.

Other properties in the immediate area made intermittent high-grade shipments. Another group formerly owned by Steve Pappas produced several small lots of high-grade during 1917–1926. Some shipments have been made in recent years by W. E. Hawkins from new work on the original Rustler claim. Couch shows no recorded production for the district and it is doubtful if the unrecorded production amounts to over $100,000.

Geology. As described by Hill and also by J. E. Spurr in U. S. Geological Survey bulletin 208, the veins in this area usually are found in a shaly limestone sometimes grading into a more massive limestone. The beds strike northerly and dip steeply to the east. This formation is believed to be the Ordovician Pogonip limestone and is overlain by Ordovician Eureka quartzite. A lower shale found in the area by Spurr has been classified as Cambrian. A small stock of quartz monzonite intrudes the sediments at the mouth of Willow Creek and has caused a little contact metamorphic alteration in the limestone. Hill also mentions an alaskite dike, 20–100 feet wide, found on the south side of Willow Creek. A few small intrusions of a glassy porphyritic andesite are found on the north side of Willow Creek.

The Quinn Canyon Mountains are separated from the Grant Range by the Cherry Creek Summit pass. On the Railroad Valley side of the pass a conglomerate, believed by Spurr to be Pliocene, was noted. Farther up the canyon is a limestone of geologic horizon above the Ordovician Eureka quartzite and mentioned by Spurr as probably Silurian and Devonian. Above this, on the summit and down the east side for several miles, are tertiary rhyolite dikes and flows.

Properties. In Gold Canyon, which is about 2½ miles southeast of Nyala, a property of indefinite ownership has been intermittently worked for gold ore for the past few years. News

items state that S. B. Fishel of Los Angeles had several men working on the prpoerty during the spring of 1950. Earl Mayfield of Tonopah installed a 25-ton mill here in about 1914 for Salt Lake City interests. It is believed that the mill operated a few summers and produced about $10,000. Lincoln mentions the Gold Springs Mining Company operating a 5-stamp mill in 1921. The ore occurs in shaly limestone, and numerous shallow workings on narrow quartz veins indicate that high-grade bunches and pockets were mined here. The principal workings are in the bottom of the canyon, near a spring, and the most recent work was found on the ridge south of Gold Canyon. Compressed air has been piped up a 36-degree slope from the canyon to two cuts on a quartz vein 4–8 inches wide.

The original Rustler patent is now owned and worked by W. E. Hawkins. Ownership of the other claims in the patented group is divided between Hawkins and the Steve J. Pappas estate. The group is situated about 3 miles southeast of Nyala in Saversburg Canyon. The Wingfield interests made a small production from near-surface workings on the Rustler in about 1914 and some shipments were made in 1948 by the present owner. It is estimated that the total production is less than $50,000. The ore values are in gold and silver, although it all carries a little lead and some copper is reported. Arsenopyrite occurs in much of the ore and in some cases makes an otherwise economical ore too refractory. Hill also notes a complex mixture of arsenopyrite with a dark mineral containing silver, copper, iron, antimony, and sulfur. The rock here is reported to be a flatly lying dark-blue limestone interbedded with shaly limestone. The old workings are said to consist of several hundred feet of shafts and adits; however, the new work is separate. A 25-foot vertical shaft has been sunk with 40 feet of inclined drift, also an adit has been started below these workings.

The Colorado group of four claims, owned by J. H. Walker of Los Angeles, is situated in Willow Creek canyon about 4 miles southeast of Nyala. The property was first located in 1913 and relocated in 1917 by Steve Pappas, who shipped a little high-grade and sold the ground several times. He always was able to go back and pick up more ore after the mine was abandoned by the purchaser. It is estimated that the total production has been about $10,000 or less. As per a report by A. E. Place of Los Angeles, dated 1927, which report is in possession of the owner, several adits have been driven on the north side of Willow Creek along the same general vein system. The lower adit, which is the longest, is in about 200 feet. Place states that most of the work has been done on a vein of white quartz, 1–3 feet wide, which contains free gold and arsenopyrite. He states that this vein can be traced for 4,300 feet. The present owner became interested in the ground in 1932 and installed a small mill with which he milled 50 tons of the better dump rock. He states that he recovered about $450 and decided to stop his activity until he could become associated with someone having a better knowledge of mining operations.

A property commonly known as the Melbourn group, lies about 1 mile above the Colorado group on the northwest side of Willow Creek. As previously mentioned, this property was discovered in 1913 and the high-grade found caused considerable excitement. The ground was later sold to Ely interests and was known as the Goodman property. Hill states that the vein strikes N. 67° W. and dips 40–70° S. It is 10–18 inches wide and consists of crushed white quartz with a green talc along the seams. The values are largely in native gold which usually occurs in the talc. The vein is in altered lime shale associated with an andesite dike. It is reported that the ground was once leased by Cassidy and Cater who produced about $25,000. The property is reportedly opened by several adits, the lower of which is known as the Goodman tunnel.

About 4 miles air line south of the Willow Creek properties is a group of fluorite claims known as the Spar, reportedly owned by A. F. W. Carlson and C. W. Jones of Bishop, California. The claims are estimated to be at an elevation of 8,000 feet. They are reached from the Adaven post office by traveling generally southwest 12 miles to the Pine Creek ranch, then 6 miles up Pine Creek. Although a "Jeep" road of sorts has been built to within a few hundred feet of the principal workings, it is necessary to walk about one-half mile up this road. The best fluorite was seen at the lower workings where a short adit and winze have been dug on a 5-foot width of high-grade spar occurring in a limestone cliff. Several short adits and cuts expose the same or a parallel shear zone bearing westerly up a steep slope. It appears that this zone is along the south contact of a large rhyolite dike with the limestone. Faulting along this area has caused a slight ravine to the ridge which is about 800 feet west of the lower adit. The owners' sample returns show values ranging from 75 to 98.6 percent CaF_2. Several exposures were seen where high-grade fluorite could be sorted from the softer waste rock.

A property of unknown ownership, known as the Dresser Mine,

is situated at an elevation of 7,900 feet in Badger Gulch off Pine Creek, 4 miles west of the Pine Creek ranch. As per information obtained from P. A. Lewis, an adit 470 feet long bears N. 80° W. in limestone containing pyrite seams which the adit apparently followed. At 110 feet in the adit is a winze flowing water. Apparently the work was done in quest of gold, but no production has been made. At the present time the adit serves as a source of water for cattle.

Another fluorite property, known as the Rainbow, owned by David Eason and Earl Mayfield of Tonopah who located it in 1945, lies on the west side of the Quinn Canyon Range about 13 miles air line southwest of Willow Creek. The property is near the northwest corner of Lincoln County and may even be in Lincoln County. About 200 tons of high-grade fluorite was shipped from here during the summers of 1945 and 1946. The ore occurs in veins from "knifeblade" size to 4-foot widths and has been mined in widths ranging from 12 inches up. The veins are in and parallel to a north bearing shear zone occurring in altered volcanics, some of which appear to be greenstones. The mining has been done in two areas about one-quarter mile apart. At the south end, 50 feet of vein 12–18 inches wide has been mined to the surface through a 25-foot vertical shaft. At the north end, about 80 feet of ore 12 inches to 4 feet has been mined to a depth of 10 feet. It appears that the ore of wider width was hand sorted.

The three mining properties in the vicinity of the Adaven post office, sometimes referred to as the Sharp area, are here included in the Willow Creek mining district; however, some mining people refer to this as the Sharp district.

The Roadside mine lies east of the road, 3.9 miles southeast of Adaven and is 75 miles west of Pioche, the nearest railpoint. Water for domestic purposes is obtained from a spring on the ground. Silver-lead ore was discovered here in June 1918 by William A. "Roadside" Smith who did much of the work on the claims and optioned the property to various parties, none of whom made any appreciable production. The claims are now owned by Roy Maroon of Tonopah. During the winter of 1938–1939, lessees shipped 238 tons of dump rock averaging 13 ounces silver, 26 percent iron, and 15 percent manganese. The gold content was negligible and no assay was made for lead. These shipments were trucked to McGill and paid for the trucking but no more. The ore occurs largely oxidized in a ferro-manganese mixture containing some lead. Samples taken by several engineers

and the owner give averages varying from 10 to 39 ounces silver and up to 12 percent lead. The latest engineer's report, made by R. J. Sampson in 1929, is in possession of the owner. Sampson states that the winze between the 50- and 100-level is in fair ore and that all of the 100-level shows ore. The workings consist of an inclined shaft 100 feet deep with about 400 feet of workings on two levels, a short adit, and several trenches. A copy of a report on adjoining claims with much information on the Roadside, made in 1919 by Jay A. Carpenter, is in the Bureau files.

The Red Bird group, owned by Joe F. Perkins of Overton, lies 1 mile around the hill to the northeast from the Roadside mine. The owner reports that in 1925 a test shipment to a smelter contained $97 per ton in lead and silver. The ore occurs as a narrow quartz vein in limestone near a prominent north-striking rhyolite dike that may be traced for several miles. A short adit and a winze, filled with water, are apparently the principal workings on the ore. About 100 feet below this, a 230-foot cross-cut adit has been driven to cut the vein exposed above, but the ore has not yet been encountered in this adit.

A patented claim, owned by the Combined Metals Reduction Company of Pioche, lies 2.5 miles northeast of Adaven on the road to Pioche. A 2-foot vein containing a mixture of pyrite, arsenopyrite, galena, sphalerite, and the oxidation products of these minerals is exposed in a 30-foot shaft and shallow pit about 40 feet apart. The vein, bearing N. 5° E. and dipping 70° W., is found in limestone almost on the contact with a large rhyolite dike. This dike bears north and is believed to be the same one found on the Perkins' Red Bird group to the south. It is understood that an attempt was made in about 1938 to work this property but that the arsenic content in the ore was too high. The ore shoot appears to be 40 feet or less in length as the vein exposure on the south end contains much arsenopyrite but a low percentage of ore minerals.

WILSONS

The Wilsons mining district is a small area on the Tolicha road 7 miles south of Antelope Springs and about 38 miles southeast of Goldfield. The district is completely within the Tonopah Bombing and Gunnery Range. S. H. Ball[133] reports that the first discovery was made in May 1904. It appears that little work has been done here in many years.

The country rock is all Tertiary rhyolite which is cut by quartz veins containing values in silver and gold with a trace of copper.

[133]Op. cit., U. S. Geol. Survey Bull. 285, p. 69.

Properties. Old workings, possibly abandoned, include a 150-foot inclined shaft and an old adit about 100-feet in length. The shaft was sunk on the dip of a 4-foot quartz vein in rhyolite. It appears that the work may have been started on near-surface enrichment of oxidized silver minerals. These enriched surface ores were usually an incentive for deeper work. A cabin on the ground is in rehabilitable condition and indicates that the last work here may have been done in the thirties.

The Pittsburg group, owned by E. J. Reed and Ed Slavin of Tonopah, is said to lie about 4 miles east of the Tolicha road and the old workings of the Wilsons district. A mineralized zone lies in and adjacent to several parallel quartz veins striking northeast. The values are in silver and gold.

The workings include a 300-foot inclined shaft with 40 feet of laterals on the 100-foot level, 175 feet on the 200, and 350 feet on the 300- or bottom level. Samples noted, indicate low silver values and some gold in the workings off the shaft. A 425-foot adit is said to show little indication of ore.

RECOMMENDED REFERENCES

Lincoln, published in 1921, has a very complete list of publications and articles on Nevada of both economic and geologic nature. In 1932 the Nevada State Bureau of Mines published "Metal and Nonmetal Occurrences in Nevada," which brought the list of references up to date at that time. Gianella's "Bibliography of Geologic Literature of Nevada," and Prince's "Bibliography of Geologic Maps of Nevada Areas," published together by the Bureau listed all writings and maps of a geologic nature up to 1945. Following is a list of the more important publications and articles pertaining to Nye County, most of which were published after the above-mentioned bibliographies:

Anderson, C. A. and Cox, M. W., Geology of the Hall Molybdenum Property, Nye County, Nevada: U. S. G. S. Preliminary Report. October 1949. (In open file, Nevada State Bureau of Mines office.)

B. M. I. Milling, Gabbs, Nevada: Mining World, November 1944.

B. M. I. Mining, Gabbs, Nevada: Mining World, December 1944.

Callaghan, Eugene and Vitaliano, Charles J., Magnesite and Brucite Deposits at Gabbs, Nye County, Nevada: U. S. Geol. Survey Preliminary Report, 1948. (In open file, Nevada State Bureau of Mines office.)

Holmes, George H., Jr., Mining Methods at the Brucite Deposit, Basic Refractories, Inc., Nye County, Nevada: U. S. Bureau of Mines I. C. 7543, 1949.

Ferguson, Henry G., Geology of the Tybo District, Nevada: University of Nevada Bulletin, Geology and Mining Series, Vol. 27, No. 3, 1933.

Ferguson, Henry G. and Muller, Siemon W., Structural Geology of the Hawthorne and Tonopah Quadrangles, Nevada: U. S. G. S. Prof. Paper 216, 1949.

Geehan, Robert W., Exploration of the Crowell Fluorspar Mine, Nye County, Nevada: U. S. Bureau of Mines R. I. 3954, 1946.

Thurston, W. R., The Daisy Fluorspar Deposit Near Beatty, Nye County, Nevada: U. S. G. S. Strategic Minerals Investigations Preliminary Report 3-209, 1949. (In open file, Nevada State Bureau of Mines office.)

Kral, Victor E., Phelps Stokes Iron Deposit, Nye County, Nevada: U. S. Bureau of Mines R. I. 4000, 1947.

Nolan, Thomas B., The Underground Geology of the Tonopah Mining District, Nevada: University of Nevada Bulletin, Geology and Mining Series, Vol. 29, No. 5, 1935.

Round Mountain Gold: Mining World, June 1950.

Maps

U. S. Forest Service maps of the Toiyabe and Nevada National Forests, 1942–1943.

The following U. S. Geol. Survey topographic quadrangles:

Bullfrog (special), 1906.
Furnace Creek, 1910.
Kawich, 1908.
Lida, 1913.
Manhattan and Vicinity (special), 1916.
Roberts Mountains, 1929.
Tonopah, 1908; and the Ione and Paradise Peak 15 minute quadrangles which cover the north half of the Tonopah quadrangle, 1950.

*Vol. 28, No. 2.	Geology of the Tungsten Deposits Near Mill City, Nevada, by Paul F. Kerr, 1934.	
Vol. 29, No. 5.	Underground Geology of the Tonopah Mining District, by Thomas B. Nolan, 1935	$0.25
Vol. 29, No. 6.	Geology of the Central Humboldt Range, Nevada, by C. P. Jenney, 1935	.25
Vol. 30, No. 1.	The Tuscarora Mining District, Elko County, Nevada, by Thomas B. Nolan, 1936	.25
Vol. 30, No. 2.	Geology of the Chief District, Lincoln County, Nevada, by Eugene Callaghan, 1936	.25
*Vol. 30, No. 4.	Placer Mining in Nevada, by William O. Vanderburg, 1936.	
Vol. 30, No. 5.	The Tungsten Mineralization at Silver Dyke, Nevada, by Paul F. Kerr, 1936	.30
Vol. 30, No. 9.	Geology of the Silver City District and the Southern Portion of the Comstock Lode, Nevada, by Vincent P. Gianella, 1936	.25
Vol. 31, No. 5.	Geology of the Delamar District, Lincoln County, Nevada, by Eugene Callaghan, 1937	.25
Vol. 32, No. 3.	Gold Deposits of Slumbering Hills, Nevada, by Frank C. Calkins, 1938	.25
Vol. 33, No. 3.	Geol. and Min. Ser. No. 31. Cambrian Formations of the Eureka and Pioche Districts, Nevada, by Harry E. Wheeler and Dwight M. Lemmon, 1939	.25
Vol. 33, No. 5.	Geol. and Min. Ser. No. 32. Nickel Deposits in Cottonwood Canyon, Churchill County, Nevada, by H. G. Ferguson, 1939	.25
Vol. 34, No. 1.	Geol. and Min. Ser. No. 33. Goldbanks Mining District, Pershing County, Nevada, by Robert M. Dreyer, 1940.	.25
Vol. 34, No. 8.	Geol. and Min. Ser. No. 34. Revisions in the Cambrian Stratigraphy of the Pioche District, Nevada, by Harry E. Wheeler, 1940	.25
Vol. 35, No. 4.	Geol. and Min. Ser. No. 35. An Investigtion as to the Presence of Commercial Quantities of Mercury and Gold in the Dry Lakes of Nevada, by Jay A. Carpenter, 1941	.25
Vol. 35, No. 6.	Geol. and Min. Ser. No. 36. Nevada's Common Minerals (Including a Preliminary List of Minerals Found in the State), by Vincent P. Gianella, 1941	.50
Vol. 37, No. 3.	Geol. and Min. Ser. No. 37. The History of the Comstock Lode, 1850–1920, by Grant H. Smith, 1943—	
	Bound Edition	2.00
	Nevada Paper Edition	.75
Vol. 37, No. 4.	Geol. and Min. Ser. No. 38. Nevada's Metal and Mineral Production (1859–1940, Inclusive), by Bertrand F. Couch and Jay A. Carpenter, 1943	.50
*Vol. 38, No. 3.	Geol. and Min. Ser. No. 39. Lower and Middle Cambrian Stratigraphy in the Great Basin Area, by Harry E. Wheeler, 1944.	

*Out of print.

Vol. 38, No. 4.	Geol. and Min. Ser. No. 40. The Geology of Nevada Ore Deposits, by Bernard York, and The Mining Districts of Nevada, by Henry G. Ferguson, 1944	$0.50
Vol. 38, No. 5.	Geol. and Min. Ser. No. 41. Quicksilver Deposits in Nevada, by Edgar H. Bailey and David A. Phoenix, 1944, 220 pp.	1.00
	Abbreviated Edition. Without mine descriptions or maps, 64 pp.	.25
Vol. 39, No. 5.	Geol. and Min. Ser. No. 42. The Geology of the Groom District, Lincoln County, Nevada, by Fred L. Humphrey, 1945. 50 pp.	.25
Vol. 39, No. 6.	Geol. and Min. Ser. No. 43. Bibliography of Geologic Literature of Nevada, by Vincent P. Gianella, and Bibliography of Geologic Maps of Nevada Areas, by Robert W. Prince, 1945	1.00
Vol. 40, No. 5.	Geol. and Min. Ser. No. 44. Tungsten Deposits of the Osgood Range, Humboldt County, Nevada, by S. W. Hobbs and S. E. Clabaugh, 1946, 32 pp.	.50
Vol. 41, No. 5.	Geol. and Min. Ser. No. 45. Early Engineering Works Contributory to the Comstock, by John Debo Galloway, 1947, 102 pp.	.75
Vol. 41, No. 9.	Geol. and Min. Ser. No. 46. Mineral Resources of Douglas, Ormsby, and Washoe Counties, by Theodore D. Overton, 1947, 88 pp.	.50
Vol. 42, No. 3.	Geol. and Min. Ser. No. 47. Late Pre-Cambrian-Cambrian Stratigraphic Cross Section Through Southern Nevada, by Harry E. Wheeler, 1948, 58 pp.	.50
Vol. 42, No. 5.	Geol. and Min. Ser. No. 48. A Contribution to the Published Information on the Geology and Ore Deposits of Goldfield, Nevada, by Fred Searls, Jr., 1948, 24 pp.	.50
Vol. 44, No. 1.	Geol. and Min. Ser. No. 49. Mineral Resources of Storey and Lyon Counties, Nevada, by Carl Stoddard and Jay A. Carpenter, 1950, 115 pp.	.50
Vol. 45, No. 3.	Geol. and Min. Ser. No. 50. Mineral Resources of Nye County, Nevada, by Victor E. Kral, 1951, 218 pp.	1.00

*Out of print.