WINNEMUCCA TO VIRGIN VALLEY OPAL MINES

ROAD GUIDE

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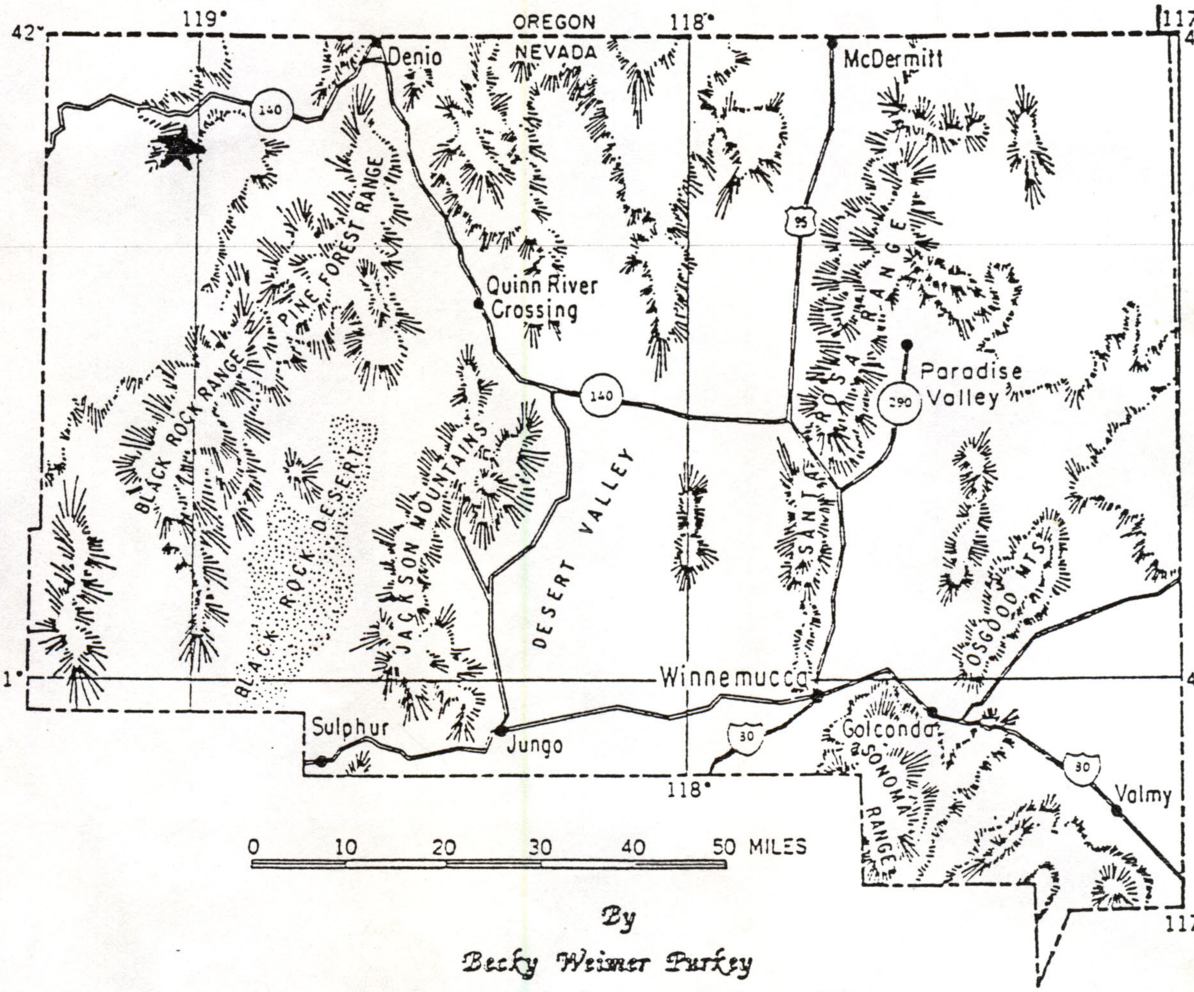

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Sponsored by
The Nevada Mining Association
The Nevada Department of Minerals

ROAD GUIDE

WINNEMUCCA TO VIRGIN VALLEY OPAL MINES

INTRODUCTION AND REGIONAL SETTING

This road guide begins in **Winnemucca**, the Humboldt County seat. Until the establishment of the Winnemucca post office in 1866, the town was known as **"French Bridge"** or **"French Ford,"** as it was a crossing point on the Humboldt River. Most of the mid-1840's emigrant trails to California passed through here before heading south through Lovelock and Reno or Dayton, or west toward Mount Lassen and northern California. When the Central Pacific set up its station here in 1868 the town was renamed Winnemucca in honor of "Old Winnemucca" or "Poito," a famous Nevada Indian chief. Winnemucca probably means "one moccasin," a combination of the word "one" and "mau-cau," which means "shoe" in Paiute.

Bordering Winnemucca on the northwest are the **Krum Hills** (and Winnemucca Mountain) consisting of Jurassic and Triassic-age sedimentary rocks and late Cretaceous to early Tertiary-age volcanic intrusive and extrusive rocks.

The **Sonoma Range** is on the south and is composed of structurally complex (folded and faulted) Paleozoic and Mesozoic marine sedimentary and volcanic rocks and Tertiary volcanic extrusive rocks.

This entire trip will be within the Basin and Range physiographic province, a region characterized by a series of generally north-trending fault-bounded mountain ranges separated by alluvial valleys that drain internally. The present-day block-faulted basins and ranges in Nevada are the result of crustal extension that began in late Cenozoic time and continues at present. **Please refer to the geologic time scale on the next page to get a sense of the relative ages of rocks being described in this guide.**

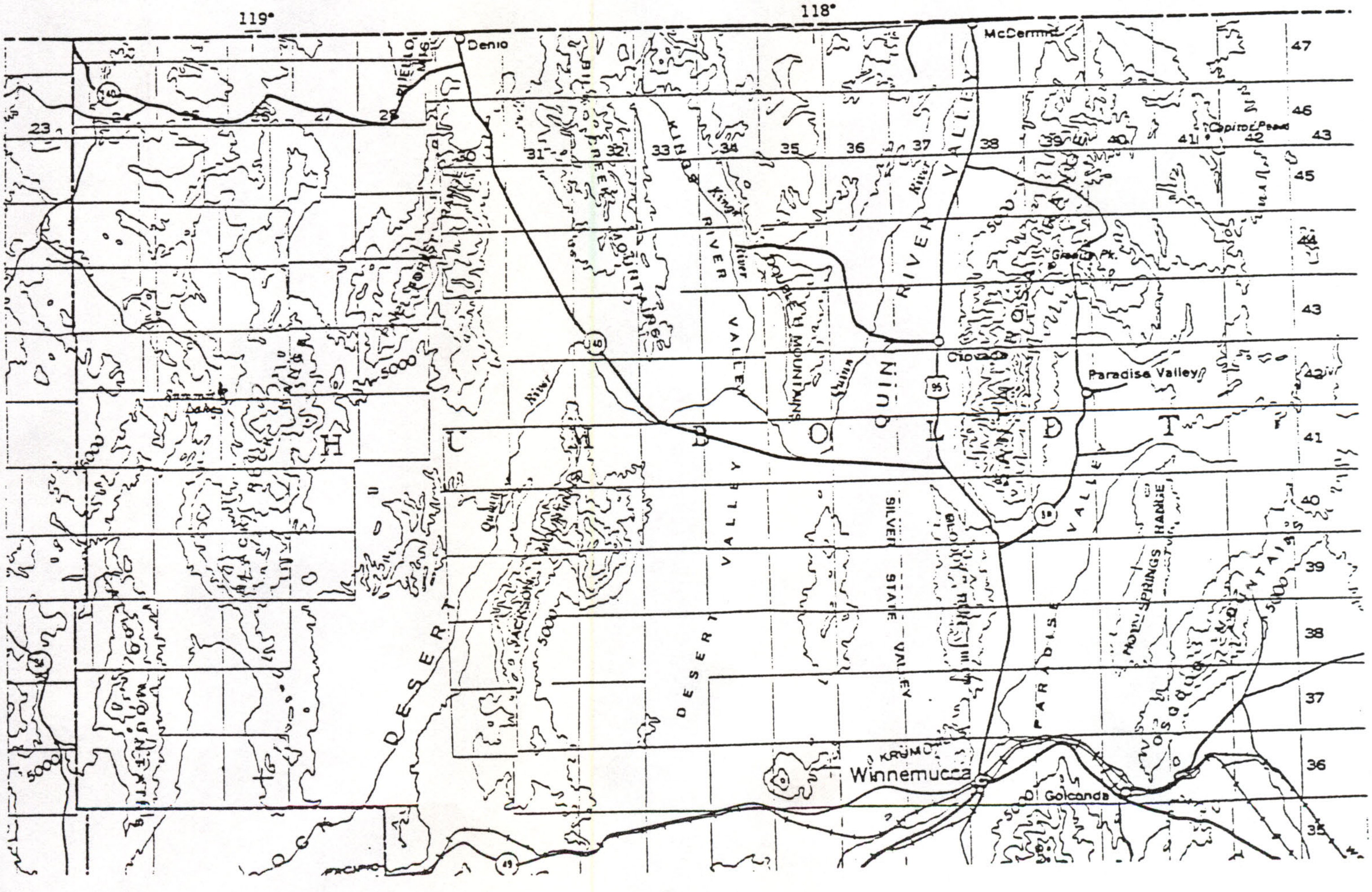
From Denio Junction westward, the landscape will change from the high ranges composed of metamorphosed old marine sedimentary rocks and granitic intrusions to black, flat-topped basalt mesas and gorges deeply incised into reddish-brown rhyolites. White ash deposits from explosive volcanic eruptions are common. This area is in the transition zone between the northern Basin and Range province and the southern Columbia River plateau province, a region characterized by great outpourings of basalt and rhyolite that occurred from 17 to 6 million years ago.

The lowest elevations passed through on this trip are near 3,900 feet (Quinn River area), and the highest peaks seen are about 9,400 feet in the Pine Forest Range.

Northwestern Humboldt County has a semiarid climate, receiving from 5 to 10 inches of rainfall annually. Temperatures are hot in the summer (over 99°F) and cold in the winter (less than 0°F).

Natural vegetation along the route consists of shadscale, rabbitbrush, sagebrush, saltbush, greasewood, horsebrush and grasses in the valleys and on the table lands; willow, cottonwood and aspen in the drainages; and bitterbrush, mountain mahogany, juniper, pinyon, and aspen at higher elevations.

Nearly 200 species of birds occupy this territory along with small and large mammals including shrews, bats, raccoons, weasels, skunks, badgers, foxes, coyotes, squirrels, chipmunks, marmots, gophers, mice, rats, beavers, woodrats, voles, muskrats, porcupines, pikas, rabbits, deer, pronghorn antelope, bighorn sheep and wild burros. Many varieties of amphibians, reptiles and fish also inhabit the wetlands and streams.



Geologic Column, Time Scale, Major Worldwide Subdivisions, Ages of Boundaries, and Origin of Names

Subdivisions Based on Strata/*Time*				Radiometric Dates[a] (millions of years ago)	Origin of Names of Periods of Paleozoic and Mesozoic and Epochs of Cenozoic
Eonothem/*Eon*	Erathem/*Era*	System/*Period*	Series/*Epoch*		
				0	
Phanerozoic	Cenozoic	Quaternary[b]	Holocene	0.01	Greek for wholly recent
			Pleistocene	1.6	Greek for most recent
		Tertiary[b]	Pliocene	5.3	Greek for more recent
			Miocene	23.7	Greek for less recent
			Oligocene	36.6	Greek for slightly recent
			Eocene	57.8	Greek for dawn of the recent
			Paleocene	66.4	Greek for early dawn of the recent
	Mesozoic	Cretaceous	Numerous units	144	Chalk (Latin = *creta*) in southern England and northern France
		Jurassic		208	Jura Mountains, Switzerland and France
		Triassic		245	Threefold division of rocks in Germany
	Paleozoic	Permian		286	Province of Perm, Russia
		Pennsylvanian[c]		320	State of Pennsylvania
		Mississippian[c]		360	Mississippi River
		Devonian		408	Devonshire, county of southwest England
		Silurian		438	Silures, ancient Celtic tribe of Wales
		Ordovician		505	Ordovices, ancient Celtic tribe of Wales
		Cambrian		570	Cambria, Roman name for Wales
Proterozoic[d]		No subdivisions in wide use		2500	
Archean[d]				3800(?)	
Hadean[e]				~ 4650	

Source: Based largely on data from Palmer, 1983.

[a]Time divisions are not drawn to uniform scale.

[b]Derived from eighteenth- and nineteenth-century geologic time scale that separated crustal rocks into a fourfold division of Primary, Secondary, Tertiary, and Quaternary, based largely on relative degree of induration and deformation.

[c]Mississippian and Pennsylvanian are equivalent to Lower and Upper Carboniferous Period of Europe (named for abundance of coal in these rocks).

[d]Proterozoic plus Archean are equivalent to Precambrian.

[e]No rocks of this eon are known on Earth, but they exist on other planetary bodies in the solar system.

BEGIN ROAD GUIDE
Mileage Interval/Cumulative Mileage

0.0/0.0 At the intersection of Winnemucca Blvd. and Melarkey Street (U.S. 95) **TURN LEFT (NORTH) ON U.S. 95.**

0.2/0.2 Crossing the **Humboldt River** and the Union Pacific (formerly Western Pacific) railroad tracks.

1.6/1.8 Winnemucca Mountain is on the left. It is composed mainly of Late Triassic metamorphosed limestones, sandstones, and shales which have been intruded by a few igneous granitic bodies in Jurassic-Cretaceous time.
Note the prospect workings of the **Winnemucca mining district** on this eastern slope. Silver and gold, and lesser amounts of copper, lead, and zinc have been produced from quartz veins occupying shear zones in the Triassic rocks or from contact metamorphic rocks near the igneous intrusive bodies. Detailed production figures for this district are not available, but estimates have been made at anywhere from $1 to 6 million since the 1870's.

A classic meander plain can be seen in the valley to the right where the Little Humboldt drains from the north to meet the **Humboldt River** flowing from the east. The Humboldt is the largest river within the Great Basin. Its headwaters are in the northeast corner of Nevada. From there it flows westward and bends south at Winnemucca to its terminus in the Humboldt and Carson Sinks. Most of Nevada is characterized by this internal drainage system, hence the name "Great Basin."

1.4/3.2 Pliocene-Pleistocene-age basalt flows are exposed in several roadcuts along the highway for the next 2 miles.

1.2/4.4 On the left is the northern part of the **Krum Hills**, which border Winnemucca Mountain on the west and north. Here the hills are composed mainly of Tertiary (Miocene) basalt and andesite flows.

On the right at 2:00-3:00 is a flat-topped mesa of Pliocene-Pleistocene basalt flows.

Ahead, locally active **sand dunes** cross the highway. Originating to the west in Desert Valley, the sand extends eastward to the center of Paradise Valley (on the right) which is drained by the **Little Humboldt River**.

4.0/8.4 Crossing the dune field. The southern toe of the **Hot Springs Range** is at 2:00. The **Osgood Mountains** (which host the Pinson, Getchell, Chimney Creek, and Rabbit Creek mines) is the high range in the distance at 4:00.

2.6/11.0 **Sand Pass Road.** At 10:00 is **Bloody Run Peak**, a granodiorite pluton (light-colored igneous intrusive rock) which intruded the existing rocks in Jurassic-Cretaceous time. It is the highest peak in the **Bloody Run Hills**, which are the southern end of the **Santa Rosa Range** ahead to the north.

Both the Bloody Run Hills and the Santa Rosa Range are composed of thick sequences of Triassic and Jurassic shales and sandstones which have been tightly folded and metamorphosed to phyllites and quartzites prior to Late Cretaceous-early Tertiary time. Both have been intruded by igneous plutonic rocks during Jurassic-Cretaceous time, and then were intruded again and overlain by Tertiary volcanic rocks. The highest peaks in the Santa Rosa Range are the Mesozoic granitic plutons. Large glacial cirques were developed in this range during the Pleistocene epoch, but have largely been destroyed by subsequent erosion.

8.8/19.8 **Paradise Ranchos Road** on the right. Irrigated alfalfa and potato fields can be seen to the right in Paradise Valley. Farming began here in 1863 by would-be miners, who, upon passing through this beautiful area on their way to the mountains, decided to trade their picks for plows. Formation of the town, Paradise City, followed soon after.

Another Mesozoic granodiorite pluton can be seen at 9:00 in the northern Bloody Run Hills. **Paradise Peak** (elev. 9,467 feet), another Mesozoic pluton, is straight ahead in the Santa Rosa Range.

2.3/22.1 Junction of **State Route 290** on the right. Continue straight ahead on U.S. 95.

2.4/24.5 Roadcut on the right is through tightly folded Triassic quartzites and mudstones of the Santa Rosa Range.

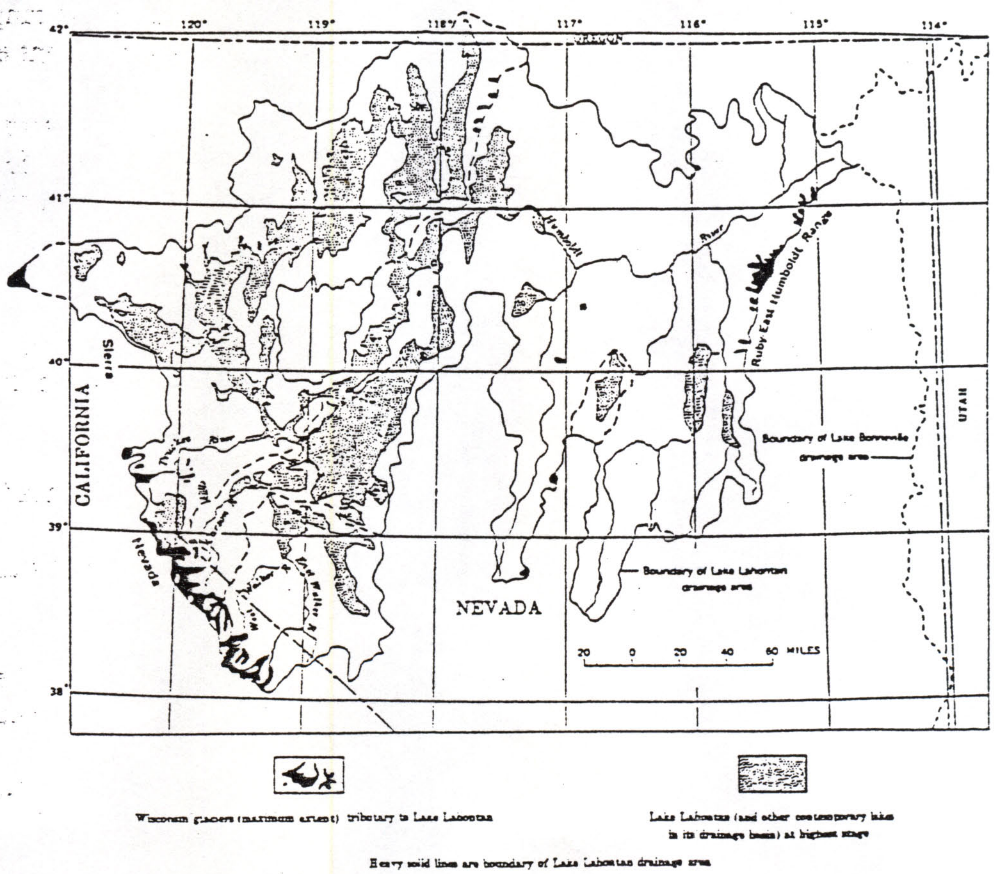
2.0/26.5 The main part of the **Santa Rosa Range** is now on the right and the north end of the Bloody Hills is to the left, here composed of Tertiary age volcanic rocks.

3.7/30.2 Note the vertical bedding in the Santa Rosa Range on the right, and the lighter-colored Cretaceous-Tertiary intrusive granite stocks.

1.4/31.6 TURN LEFT (WEST) ON STATE ROUTE 140.

0.8/32.4 Crossing the **Quinn River Valley** (to the right) and the **Silver State Valley** (to the left).

These two valleys, along with the Blackrock Desert ahead, were part of ancient **Lake Lahontan** which existed mainly in western Nevada during the Wisconsinan stage (begining about 75,000 years ago) of the Pleistocene epoch. During interglacial periods, when glaciers in the Sierra and other local high ranges (Pine Forest and Santa Rosa Ranges) were melting, many of the valleys in western Nevada were filled with the meltwaters to form a large interconnected lake. Many other smaller, separate lakes formed also. The climate was wetter and cooler then, which also contributed to the increased amount of surface water in this region. At its maximum, Lake Lahontan was the second largest pluvial lake in the Western Hemisphere (Lake Bonneville in Utah was the largest). It covered an area of almost 8,500 square miles (about the size of Lake Erie). The highest recognizable shorelines of this lake in Humboldt County are at an elevation of about 4,400 feet. Many other levels of wave-cut terraces can be seen in older alluvium along the range fronts. Present-day remnants (and formerly deepest basins) of Lake Lahontan are Pyramid and Walker Lakes and the Carson Sink.



Map showing location of report area and area inundated by Lake Lahontan.

The **Slumbering Hills** are in the near distance at 11:00.
The higher **Jackson Mountains** are on the skyline beyond. The **Pine Forest Range** is on the skyline at 1:00, and the southern end of the **Double H Mountains** composed of rhyolite ash-flow tuffs and flows is on the right at 2:00.

The **Slumbering Hills** consists of Triassic metamorphosed siltstones and sandstones (now phyllites, shales, and quartzites) which have been intruded by a Mesozoic granitic stock near the center of the range. Overlying the Mesozoic rocks are Tertiary volcanic [rocks occurring as] flows, dikes, and sills.

The **Awakening (Jumbo) mining district**, consisting of mostly small gold mines, lies on the north end of the Slumbering Hills. The **Jumbo mine** produced most of the district's production of approximately 280,000 tons of ore from 1935 to 1964. The **newest mine in the area, the Sleeper mine, is located** on the northwest end of the Slumbering Hills. Here, electrum (containing 30 percent silver by volume) and native gold occur disseminated in hydrothermal breccias and quartz veins. Production began full scale (500 tons/day) in March 1986. Production in 1988 totalled 230,410 ounces of gold. Reserves were estimated at 3.4 million tons of 0.317 oz gold/ton mill-grade ore and 44.9 million tons of 0.021 oz gold/ton heap-leach ore.

12.4/44.8 Sod House Road (just before FAA radio beacon on the left) leads to the Sleeper mine just over the hill to the left. Continue straight ahead.

1.9/46.7 **Sod House and Sod House Point on the right.** Sod House Station was a building made entirely of sod. It has been a landmark in the area since about 1880. Peter Skene Ogden passed by this site in November 1828.

The **Double H Mountains** are at 3:00. A deep arroyo of the Quinn River parallels the road on the right. A geothermal well is located on the left side of the road here.

The **Jackson Mountains** are ahead on the left. The **Pine Forest Range** rises directly ahead in the distance. The **Bilk Creek Mountains** (also known as the Kings River Range) are the low range ahead on the right.

5.6/52.3 Crossing Creek Slough.

6.1/58.4 **Bottle Creek Road** on the left leads to the northernmost of three mining districts in the Jackson Mountains (the other two districts are Jackson Creek and Red Butte).

The **Jackson Mountains** are composed mainly of Permian or older volcanic rocks; Permian and Triassic volcanics, shales, conglomerates, limestones and chert; and Tertiary intrusive and extrusive volcanic rocks and associated sedimentary rocks. These units were intruded by granodiorite stocks and thrust-faulted (older rocks thrust over younger rocks, thus reversing the age sequence of the rock section) during Cretaceous-Tertiary time.

Humboldt County's only iron and sulfur mines are in the Jackson Mountains. Some of the sulfur mines are of particular interest because they are very recent (late Quaternary age) and formed at hot springs that existed near the highest water level of ancient Lake Lahontan. Mercury ore has been produced here, along with gold, silver, copper, lead and zinc. Mineral production in the Jackson Mountains from 1898 to 1957 totalled about $4,400,000.

The Jackson Mountains are now part of the North and South Jackson Mountains Wilderness Study Areas.

0.3/58.7 Crossing the **Quinn River**. The boundary of the **Fort McDermitt Indian Reservation** parallels the road on the right. The Quinn River, which originates in Oregon northeast of the Santa Rosa Range, will now be on the left side of the road as it drains south into the Black Rock Desert basin.

3.3/62.0 Note the springs to the right of the road. You are passing the southern end of the **Bilk Creek Mountains** (Kings River Range).

This range is composed mostly of late Tertiary volcanic rocks; however, small areas of Permian through Triassic-age rocks are exposed at both ends of the range, and large areas of Cretaceous-Tertiary intrusive granodiorite crop out in the northern portion of the range. Thrust faults (where older rocks have been thrust over younger rocks during periods of intense tectonism) occur in this range, as in most of the ranges along this tour. Ore deposits are almost unknown in this range.

Ahead, is the **Pine Forest Range**.

4.2/66.2 Passing the northern toe of the Jackson Mountains on the left.

2.1/68.3 **Leonard Creek Road** on the left.

1.2/69.5 Look left into the northern end of the **Black Rock Desert** which separates the Jackson Mountains (behind on the left) from the Pine Forest Range (directly ahead) and the Black Rock Range (at 9:00). The northern half of the Black Rock Desert is included in the Black Rock Desert Wilderness Study Area.

0.5/70.0 **Quinn River Crossing** is to the left about 1 mile. Quinn River is a small settlement that serves area ranches. According to the Federal Census of 1870, the original name may have "Queens River."

1.0/71.0 **Bilk Creek Reservoir Road** to the right. Note the ridge of Tertiary basalt, faulted and upturned to the northeast. The nearest exposed rocks of this type and age are located about 7 miles to the southeast in **Sentinel Peak** (at 9:00).

4.7/75.7 Irrigated fields on the left.

4.9/80.6 Crossing the creek that drains **Howard Hot Spring** on the right. Spring temperatures have been documented at from 118° to 163°F.

The route now passes along the steep eastern front of the **Pine Forest Range.**

Duffer Peak (at 9:00) is the highest peak in the range at an elevation of 9,458 feet. It is composed of light-colored Late Cretaceous-early Tertiary granodiorite that has intruded and metamorphosed older Permian volcanic rocks and Triassic-Jurassic limestones and clastic sediments, converting them to schist, gneiss, slate, marble and quartzite. Tertiary volcanic and sedimentary rocks are found resting on top of all of these rocks.

This range exhibits many **glacial features** (moraines, hanging valleys, and several small cirques) [higher up], and is well watered. Most of the central and southern part of the range is included in the Alder Creek and Blue Lakes Wilderness Study Areas.

4.0/84.6 Maintainance yard on the left. **Mahogany Mountain** (elev. 7,938 feet) is ahead at 10:00.

The highest peaks in the Bilk Creek Mountains (around 8,500 feet) are now visible at 2:00. The light-colored rocks are intrusions of Late Cretaceous-early Tertiary granodiorite.

3.4/88.0 Note the granitic rocks (light-colored) on the left and groves of trees marking the sites of springs. Just beyond these rocks (over the summit) is the **Ashdown mining district.**

3.2/91.2 **Denio Summit.** Start descending into **Antelope Valley.**

4.0/95.2 **Black Mountain**, composed of Tertiary basalt, is on the left at 10:00. The **Pueblo Mountains** are directly ahead and at the southern end are composed of Tertiary volcanic rocks. **Pueblo Valley** spans northeastward (ahead and to the right).

3.1/98.3 DENIO JUNCTION. TURN LEFT ON HIGHWAY 140. (NOTE: If you stop here for gas or refreshments please make any mileage/odometer adjustments for the upcoming described points of interest.)

1.1/99.4 The northern end of the **Pine Forest Range** is on the left.

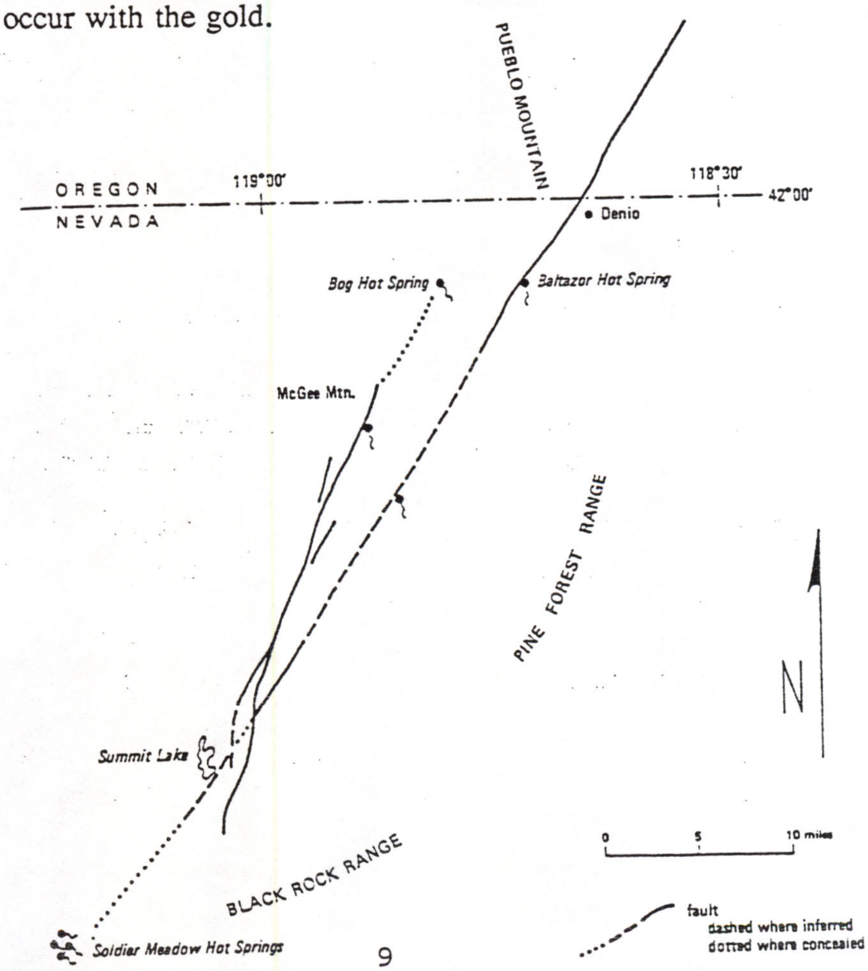
Zigzag roads lead up to small mines and prospects in the **Pueblo Mountains** to the right. No important production has been reported from this southern end of the range.

4.0/103.4 Road on the left leads to **Baltazor (Continental) Hot Springs.** Surface water temperatures at the springs are near 200°F, and small deposits of travertine and siliceous sinter can be found.

These springs lie along a fault which bounds the east side of the Pueblo Mountains and forms part of a lineament 65 miles long that extends from Soldier Meadow Hot Springs at the southern end of the Black Rock Range north through this area into Oregon. Researchers have suggested that this lineament existed as a large fault in the early Tertiary terrain. After thick deposits of volcanic rocks were deposited in this region during Oligocene and Miocene time, displacement occurred along this fault to throw the Pueblo Mountains volcanic section above the present valley floor. (Note the abrupt escarpment of the Pueblo Mountains along the right side of the road.)

0.8/104.2 **Continental Lake** (a playa) on the left.

1.4/105.6 Note the workings of the **Ashdown mine** up in the Pine Forest Range at 9:00. Currently inactive, this was the largest mine in the Ashdown mining district. Less than 1,000 ounces of gold was mined since the mid-1900's, occurring as free gold in quartz veins in granodiorite. Small amounts of pyrite, tetrahedrite, and galena also occur with the gold.



Relation of a lineament in northwestern Humboldt County to hot springs (modified from Hose and Taylor, 1974).

1.9/107.5 Rounding the southern toe of the **Pueblo Mountains,** the route bends abruptly westward. The road on the right leads to **Bog Hot Springs.** The springs are located at the northern end of a fault that parallels the Baltazor Hot Springs fault lineament and intersects it on the south at Summit Lake on the west side of the Black Rock Range. The springs are reported to discharge as much as 1,000 gallons per minute. The highest surface water temperature reported is 131 degrees F. The springs have been used since the early 1900's for stock watering and irrigation of hundreds of acres of wild hay. The waters are also presently being used for domestic water supply and hot mineral water baths on the Bog Hot Springs Ranch.

0.2/107.7 Road on the left leads to Alder Creek Ranch, the Ashdown mine, and accesses the heart of the Pine Forest Range recreational area. Some of the high lakes in the range are dammed for irrigation purposes and are low during drought years.

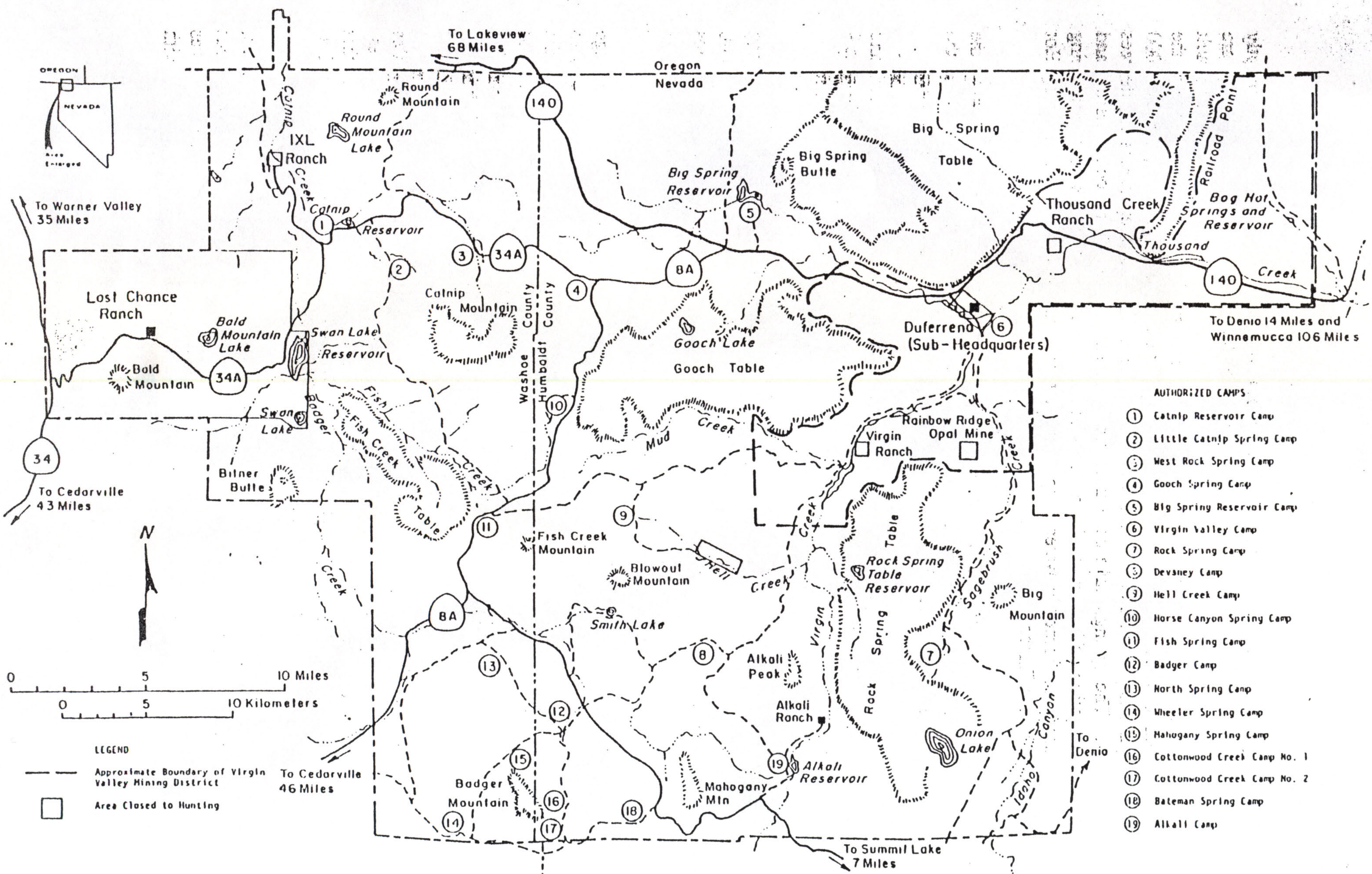
The route now passes through **Bog Hot Valley** (which extends to the north and south). The parallel streams of **Thousand Creek** are on the right for the next 9 miles.

1.2/108.9 Entering the **Charles Sheldon National Wildlife Refuge.**
The original Antelope Refuge was formed in 1931 and contained just over 34,000 acres. In 1936, the Antelope Range was established, comprising over 540,000 acres. Today, the two areas are combined to include over 575,000 acres administered by the U.S. Fish and Wildlife Service. The remainder of this tour will be in the Refuge.

McGee Mountain is ahead on the left at 10:00. It forms the northeastern edge of **Rock Spring Table,** an upland composed of middle Miocene (about 14 to 16 million years old) Canon Rhyolite flows. A northwest trending fault (called the Thousand Creek scarp) bounds this plateau on its northeast side (to the left and ahead) for a distance of almost 15 miles and accounts for the abrupt break in the landscape. The rocks forming the upland were faulted upward over 600 feet along this fault.

Rocks on both sides of the road (above the valley alluvium) for the next 7 miles are early to middle Pliocene tuffaceous (volcanic ash) sedimentary rocks (shales, sandstones, mudstones and conglomerates) called the **Thousand Creek Beds** that were deposited 17 to 6 million years ago. These rocks span many square miles, but are only a few hundreds of feet thick.

Fossilized faunal remains (widely scattered bone fragments) include horses, mastodons, camels, dogs, large cats, antelopes, rhinoceroses, geese, and various rodents, reptiles, and fishes. The depositional environment at the time was probably not that much different than today. It was a region of plains, with



SHELDON NATIONAL WILDLIFE REFUGE

occasional lakes or meadows bordering rugged or elevated areas. The climate was cooler and more humid than now, with more abundant vegetation.

Ahead is **Railroad Point**, a long, low, black ridge capped by Pleistocene-age basalt. It is the cast of a former stream channel that was filled with molten lava about 1.2 million years ago. After the softer sediments along the channel were eroded away, a mesa was formed, capped by the more resistant basalt.

4.9/113.8 **Thousand Creek Gorge**, directly ahead, is carved in a thick unit of exhumed Miocene Canon Rhyolite, the same unit that makes up McGee Mountain. This resistant rock unit forms bold cliffs and steep-walled canyons. It has a total thickness of 394 feet at the mouth of the gorge. This portion of **Rock Spring Table** was uplifted (domed) during late Tertiary-early Quaternary time. Thousand Creek was able to downcut its channel (already established in the Virgin Valley Beds that formerly covered the Canon Rhyolite) at least as fast as uplift occurred.

Thousand Creek is fed by the waters of three drainage systems: Sagebrush Creek to the south, Virgin Creek to the southwest, and Big Spring Creek to the west. Thousand Creek then flows east into continental Lake.

5.2/119.0 Rock Spring Table is still on the left as the road starts to climb a winding grade. In the roadcuts, note the sedimentary slump features and varved deposits characteristic of water-laid sediments. These rocks are more of the Thousand Creek Beds (tuffs and sedimentary rocks). They depict a shallow water depositional environment for intermittant volcanic products and other rock fragments and local flora and fauna, mainly horses.

1.3/120.3 **IF SAFE TO DO SO**, park your vehicle on this straight stretch, well off the road, for a closer look.

The Thousand Creek Beds are on the right (north). Just above these white sedimentary rocks filled with carbonaceous material and exhibiting deformed sedimentary structures and faults, is the Miocene Catnip (or Mesa) Basalt of Big Spring Table (a volcanic plateau to the northwest) dated at about 9 to 10 million years old. The older, upthrown Canon Rhyolite (reddish rocks) is on the left (south).

Several faults intersect here. The northwest-trending fault that bounds the north side of Rock Spring Table along with several shorter parallel faults, intersects a northeast-trending fault that cuts the northwest edge of Rock Spring Table and possibly extends northeast along the right (north) side of the road and the southeastern edge of Big Spring Table.

Northwest- and northeast-trending faults are common in this part of Nevada and are a result of tension produced in the overlying homogeneous rocks (basalt and rhyolite flows) due to the withdrawal of large volumes of magma from underneath this area. From detailed mapping and dating of the various volcanic rock units, it has been concluded that much of the faulting present in the area occurred after 9.4 million years ago and before about 1.6 million years ago (late Miocene through Pliocene time). The faults are normal, with average vertical displacement of from 60 to 200 feet.

0.4/120.7 Passing through a roadcut of Thousand Creek ash-fall tuff and pumice layers. These poorly consolidated materials indicate a cooled ash fell on a dry land surface.

U.S. Geological Survey geophysicists working in this region in the early 1980's have outlined gravity anomalies in this area that may indicate the boundaries of calderas (saucerlike depressions) which formed as a result of the explosive release of large volumes of ash flows (rhyolite tuffs) in this region and which later were filled-in with tuffaceous sediments. There is no surface expression of these calderas now. (See the enclosed geologic map.)

1.3/122.0 Entering a volcanic "badland" topography, composed of more Thousand Creek Beds.

1.6/123.6 **TURN LEFT** into the **Duferrena Ranch and Refuge Sub-headquarters.**

0.9/124.5 Some of the Duferrena ranch buildings are made of local red tuffs (partially welded ash falls) from several quarries in the **Virgin Valley Beds** on the east side of the valley. This stone was also shipped to Winnemucca for final dressing and sale. It was cut on site using cable saws and sand from the dunes north of Winnemucca. Fish fossils have been found in this tuff.

0.4/124.9 Red tuffstone quarry on the left. Note the southwest entrance to **Thousand Creek Gorge** at 9:00. Continue straight ahead.

1.1/126.0 **Virgin Valley Camp area** on the left. Latrines, a spring-fed pool, and a shower house are located here, along with camping spots.

1.9/127.9 **TAKE RIGHT FORK OF THE ROAD** to **Virgin Valley** and the Royal Peacock opal mine. The road now passes through the Miocene Virgin Valley Beds. Although the rocks look similar, the fossils buried within show the Virgin Valley beds to be older than the Thousand Creek Beds. Only a species of mastodons, camels, and a species of large cats are common to both geologic periods.

0.6/128.5 **Entering Virgin Valley**. Virgin Creek is on the left.

Virgin Valley was a major basin of continental sedimentation in middle to late Miocene time. Almost 1,500 feet of tuffaceous sediments accumulated here. The original sinking (down-warping) of this basin area began before the Canon Rhyolite was deposited, and was probably due to the emptying of a magma chamber below. Its contents (lava and ash) erupted through fissures and vents onto the local land surface between periods of quiet (quiesence). Geologists have determined that most of the rhyolite and basalt flows in this area came from nearby, closely-spaced vents, with the molten volcanic rock travelling up to several miles and covering areas of at least 7 square miles in extent.

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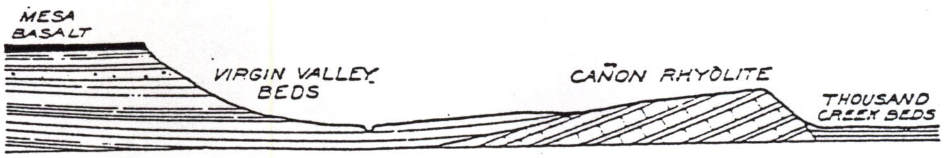


The **Virgin Valley Beds** rest upon the middle Miocene Canon Rhyolite (14 to 16 million years old) and have been protected by the overlying late Miocene Catnip Creek (Mesa) Basalt (9 to 10 million years old), which now forms extensive table lands on each side of the valley.

NOTE the large landslide blocks on either side of Virgin Creek. As water percolates through and around the overlying basalt, small streams wash away the softer Virgin Valley beds. The mesa top then breaks and slumps down the steep slopes. (Note: Many opal occurrences are in these landslide masses.)
The Virgin Valley Beds consist almost entirely of volcanic ash and tuff, with characteristic horizons of gravel, sand, clay, lignite (or carbonaceous shale), diatomite, and bedded opal and opalized plant remains.

During deposition of the Virgin Valley Beds, there were changes in the physical environment of this area. Rocks (lignite deposits and carbonaceous shales) in the lower portion of the formation indicate that large areas were covered by swamps or moist ground. The area was partially forested during deposition of the middle and upper layers as evidenced by the abundant fossil remains of large conifer-like trees, rushes and willows.

Mammalian fossil remains (including horses, camels, rhinoceroses, mastodons, "deer", large cats, and reptiles, fish, and rodents) are found mainly in the middle and upper portions of the formation and indicate a fairly open country with forests, perhaps rather large lakes, and swampy areas.
The climate was wetter and somewhat warmer than today, and the general elevation was probably around 5,000 feet. Faulting had already produced irregularities in the topography, but erosion gradually filled in the depressions to form a landscape of plains or shallow lakes of wide extent.

5.5/134.0 **TURN LEFT** into the Royal Peacock Mine.

0.6/134.6 Follow roads to the right and arrive at the main house of Art and Mary Ann Wilson. An opal shop, showers, mine registration, and camping spots are available here.

VIRGIN VALLEY OPAL

Opal is an amorphous (no crystal structure), hydrated (anywhere from 3 to 20 percent of the stone's weight is water), porous form of silicon dioxide. The nearest family of minerals is the quartz family. Precious opal is made up of minute spheres of silicon dioxide with spaces between them which are filled with water. Depending upon the size of the spheres and their spacing, light is refracted into varying wavelengths producing various colored opals.

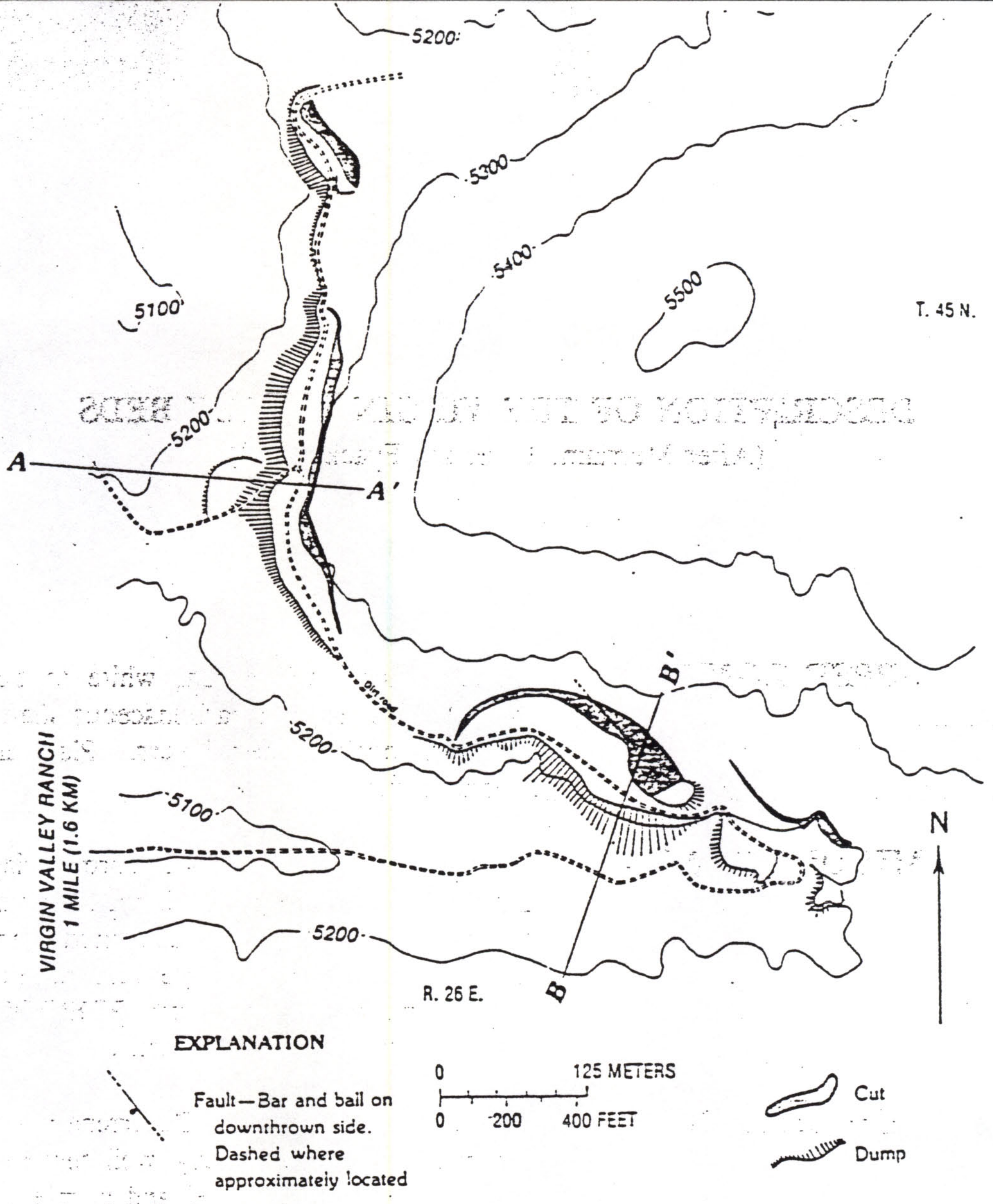
The Virgin Valley opals have long been noted for their quality, brilliance, and fire. Although production has been relatively small and intermittant, millions of dollars in opals have been taken from Virgin Valley since 1905. The Robeling Opal and fourteen other spectacular opals are on permanent display at the Smithsoniam Institute in Washington, D.C.

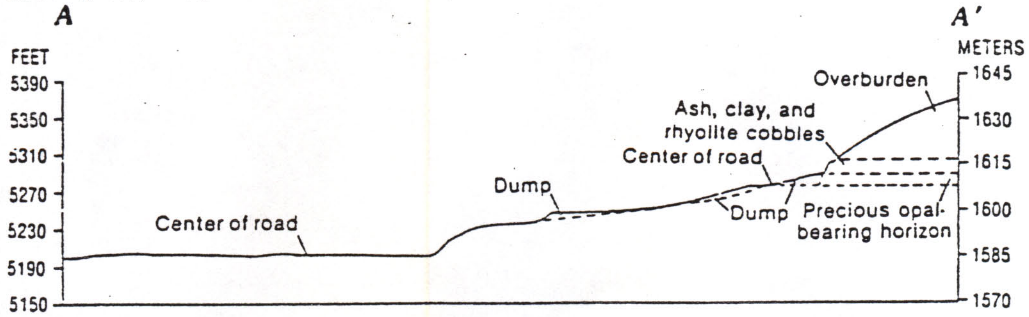
In a wet, volcanic environment such as Virgin Valley was during Miocene time, opal was probably formed as superheated water moved though the ash (silica) and other sedimentary units deposited here. The hot water dissolved silica out of the ash and deposited it as a gel in layers or in the cavities of buried, partially decayed trees.

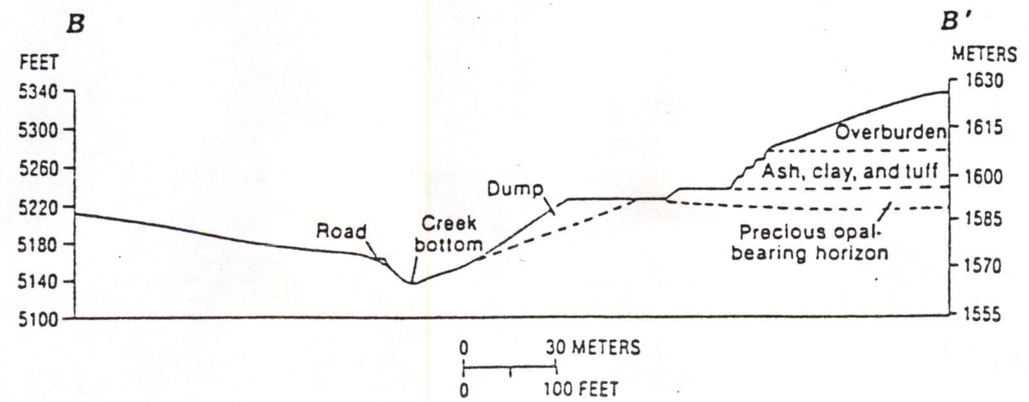
Silicification (the introduction of or replacement by silica) of ash and tuff in the middle Virgin Valley Beds has produced partly opalized rocks that resemble silicified shale to completly altered rock that is massive in outcrop; fractures conchoidally (a smooth curved surface); and is a translucent brown, gray, pale green or white in color. Some of this opal is radioactive. The yellow mineral carnotite can be found as fracture coatings or as fine layers in the opal. The rare precious fire and black opals are found mainly replacing twigs and limbs in this part of the formation.

The Royal Peacock claims are in an 8-foot thick (maximum) opal-bearing horizon of the middle Virgin Valley beds. The unit consists mainly of greenish bentonite (a clay formed from the decomposition of volcanic ash) which contains pods of ash, rhyolite pebbles, petrified wood, and opal.

!! HAPPY HUNTING !!


5200
5300
5400
5500
5100
T. 45 N.
A
A'
B'
B
5200
5100
5200
N
VIRGIN VALLEY RANCH
1 MILE (1.6 KM)
R. 26 E.
EXPLANATION
Fault—Bar and bail on downthrown side. Dashed where approximately located
0
125 METERS
0
200
400 FEET
Cut
Dump


A
A'
FEET
METERS
5390
5350
5310
5270
5230
5190
5150
1645
1630
1615
1600
1585
1570
Overburden
Ash, clay, and rhyolite cobbles
Center of road
Dump
Dump
Precious opal-bearing horizon
Center of road


B
B'
FEET
METERS
5340
5300
5260
5220
5180
5140
5100
1630
1615
1600
1585
1570
1555
Overburden
Ash, clay, and tuff
Dump
Road
Creek bottom
Precious opal-bearing horizon
0
30 METERS
0
100 FEET

DESCRIPTION OF THE VIRGIN VALLEY BEDS

(After Merriam, 1910; and Fyack, 1963)

UPPER ZONE - Rather resistant white ash, white to buff colored siliceous tuff; carbonaceous shales; diatomite; opaline chert layers. Plant and animal fossils.

MIDDLE ZONE - Easily eroded gray to yellow and brown clays and shales; bentonite (a clay formed from the decomposition of volcanic ash) mudstones; diatomite; ash and tuff; lignite; carbonaceous shales; opalized limb casts; PRECIOUS OPAL. Plant and animal fossils.

LOWER ZONE - (Represented in the Duferrena sub-headquarters area.) Fairly well-cemented white, light gray, pale red and purple and green tuffs, siltstones, and tuffaceous sandstones and shales.

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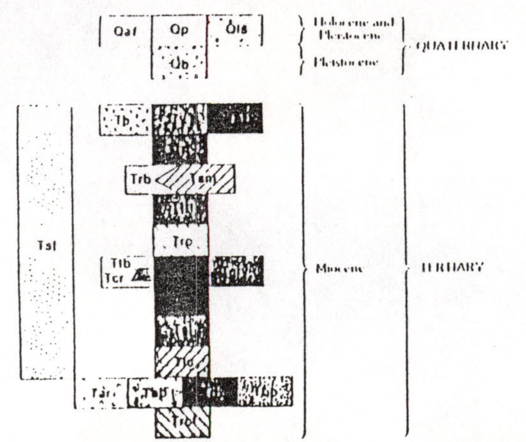
MAJOR FORMATIONS AND SEQUENCE OF EVENTS

ALONG THE ROUTE FROM RAILROAD POINT TO VIRGIN VALLEY

Geologic Epoch	Rock Formations Deposited
Holocene and Pleistocene	Alluvium and Alluvial fans (confined to Thousand Creek and Virgin Valleys
	Playa (lake) deposits
	Landslide deposits
--------------	(period of erosion)
Pleistocene	Basalt of Railroad Point
--------------	(period of erosion)
Pliocene	Thousand Creek Beds
--------------	(period of erosion, faulting, uplift) - Thousand Creek fault scarp and many other faults activate. - Thousand Creek and Virgin Valley Canyons are downcut.
Miocene	Catnip Creek (Mesa) Basalt
	(period of erosion of upper to middle portion of Virgin Valley Beds)
	Virgin Valley Beds
	(period of erosion)
	Canon Rhyolite
	(downwarping of Virgin Valley area)

CORRELATION OF MAP UNITS



LIST OF MAP UNITS

Qaf	ALLUVIUM AND ALLUVIAL FANS (HOLOCENE AND PLEISTOCENE)
Qp	PLAYA DEPOSITS (HOLOCENE AND PLEISTOCENE)
Qls	LANDSLIDE DEPOSITS (HOLOCENE AND PLEISTOCENE)
Qb	BASALT OF RAILROAD POINT (PLEISTOCENE)
Tsl	TUFFACEOUS SEDIMENTARY ROCKS (MIOCENE)
Tb	BASALT OF CATNIP CREEK (MIOCENE)
	MAFIC VENT COMPLEXES (MIOCENE)
	PALAGONITE TUFF (MIOCENE)
	RHYOLITE OF NUT MOUNTAIN (MIOCENE)
Trb	RHYOLITE OF BADGER MOUNTAIN (MIOCENE)
Tsm	SOLDIER MEADOW TUFF (MIOCENE)
	TUFF OF TROUGH MOUNTAIN (MIOCENE)
Trp	RHYOLITE OF CATNIP MOUNTAIN (MIOCENE)
Tcr	CANON RHYOLITE OF MERRIAM, 1910 (MIOCENE)
Ttb	TUFF OF BIG MOUNTAIN (MIOCENE)
Tcrd	RHYOLITE DIKE (MIOCENE)
	RHYOLITE VITROPHYRE (MIOCENE)
	RED WELDED TUFF (MIOCENE)
	SUMMIT LAKE TUFF (MIOCENE)
Tic	IDAHO CANYON TUFF (MIOCENE)
Tal	ANDESITE OF ROUND MOUNTAIN (MIOCENE)
Tab	ANDESITE OF BALD MOUNTAIN (MIOCENE)
Td	DACITE (MIOCENE)
Tpb	PORPHYRITIC BASALT (MIOCENE)
Trcl	RHYOLITE OF COTTONWOOD CANYON (MIOCENE)

CONTACT—Contacts in cross section inferred

FAULT—Bar and ball on downthrown side, dashed where inferred, and dotted where concealed

BOUNDARY OF CALDERA INFERRED FROM GEOPHYSICAL DATA (PLATE 2)

SAMPLE LOCALITY FOR POTASSIUM ARGON DATES (TABLE 1)

MINE OR PROSPECT

Geologic map of the Virgin Valley area (C[illegible] [illegible])