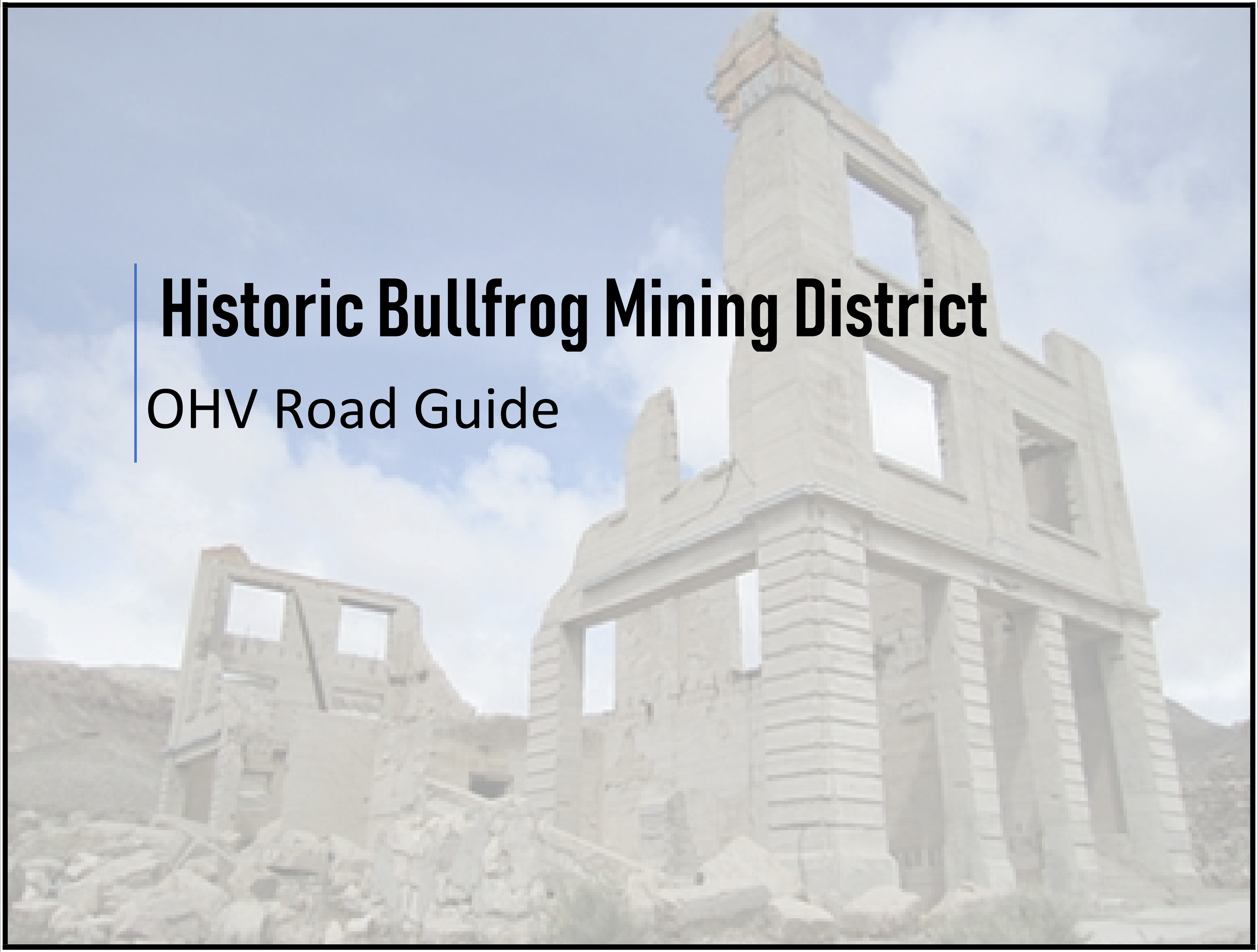
Historic Bullfrog Mining District

OHV Road Guide



1 Fluorspar Canyon Road
UTM 11N E0522462 N4082835
36.891222, -116.747909

The first 3 miles of this road passes between the new and the old, geologically speaking. On your left across from Station 1 you can see the relatively young reddish-brown basalt flows of Beatty Mountain capping the ridge. The underlying Timber Mountain tuffs form white, tan and pink layers. These young volcanic rocks erupted from the heart of the Southwest Nevada Volcanic Field centered on the western half of the Nevada Test Site. Repeated eruptions occurred in this area from 10 to 11 million years ago (m.y.a.) during the Miocene Epoch of the Tertiary Period in Geologic Time.

In contrast on your right you see the rugged slopes of Bare Mountain. These rocks range in age from 350 to 600 million years in age (during the Devonian, Silurian, Ordovician and Cambrian Periods and into the late Pre-Cambrian). The units consist of rocks largely deposited in water – mud, sand and limestone – that have been buried, compressed and changed to shale, quartzite, limestone and marble. The units have been broken by repeated faulting-- pushed together, pulled apart, and tilted-- until they formed the contorted mountain you see today.

Both periods of geologic activity play an important role in the development of mineral deposits in the area. Volcanic activity generates heat and brings an influx of minerals. This heat drives water-- both introduced with the volcanic material and existing water in the surrounding rock-- through broken zones created by faulting and folding. This allows mineralized fluids to percolate through chemically reactive rocks-- limestone is especially receptive. The resulting chemical reaction, called hydrothermal mineralization, can cause precipitation of some minerals, including both common and precious metals. Over time, build up of these minerals can create ore deposits-- minerals concentrations that can be recovered by mining methods. After Ed Cross and Shorty Harris's 1904 discovery of gold at Bullfrog Mountain, prospectors from far and wide descended on the area, and some prospected these same hills.


Fluorspar Canyon Road, taken by Bob Adams, September 16, 2014

2 Fluorspar Mine
UTM 11N E0527251 N4081959
36.883199, -116.694194

If you want to walk around the mine area, please be careful of the hazards. The shaft has been covered by concrete slabs, however, there is an open area on the southeast end of the shaft that was covered by chain-link fencing. Someone has cut some of the chain link and this area should be avoided-- especially if you have children-- as the opening is not secure.

There is also fencing around the perimeter of the shaft area to guard against the collapsed mining areas. Open spaces underground were left when the ore was removed. They may have been stabilized by timber supports, but wood rots in the humid conditions underground. Rainfall also tends to destabilize the ground over time as it trickles down through the broken rock. What appears to be solid ground can give way providing a rapid and unwelcome trip underground. Do not stray beyond the fenced area NE or SE of the mine shaft area. The dump of non-ore rocks (coarse white calcite is common) lies in the wash to the southwest of the cabin area. This area should be safe for rock hunting.

Not everyone that got into the mining game was a prospector. Some just had the finances and know-how to get a mine going. One such promoter was named Irving Crowell. During the excitement of the Bullfrog boom, he bought the Chloride Cliff mine which was discovered in 1871 by August Franklin. He had no more luck than Franklin at making the gold mine profitable. However, a prospector that worked for Crowell found a deposit of fluorspar in the hills east of Beatty. It was known at the time that fluorspar (calcium fluoride) can be found near surface above a deeper gold deposit-- one of those chemical reactions we talked about. Crowell bought the claim on the spot for $500. However, he did not move to the Beatty area to develop the property until 1917.

It turned out that fluorspar is used in the production of steel. Crowell sank an inclined shaft to get down to the lenses of ore, which is generally purple or yellow in color. Small pieces may still be found on the waste dump. They hauled the ore to Beatty by truck where water was available to process the fluorspar, and the railroad was available to transport it to market. They even built a loading ramp from the processing area right up to the Las Vegas & Tonopah siding. (The LV&T railroad grade is the location of much of U.S. Hwy 95 today.)

Everything fell into place for a successful mining operation. However, in 1923 Crowell was badly injured in a train accident on his way to Los Angeles. He was unable to work the rest of his days.

The fluorspar mine was largely idle until 1927 when his son, Irving Crowell, Jr., reopened the mine. He had been working at a steel smelter in southern California when the foreman there told him he was “a plain damn fool to work for somebody else when you have a fluorspar mine." Crowell got an agreement with U.S. Steel in Torrance, California to buy his fluorspar for their smelting operations. He later got a contract with Bethlehem Steel as well. And with his personal experience at the steel mill, he learned that his ore was high enough grade to ship without milling.

Ore was drilled by hand auger, broken by stick dynamite and hand sorted for grade quality. Then it was trucked to Beatty for shipping on the Tonopah & Tidewater Railroad to southern California. The railroad ceased operations on June 15, 1940 and thereafter the ore was trucked to Las Vegas for shipping to its destination. In later years, when the steel industry diminished in southern California, Crowell's son and grandson sold their fluorspar to cement manufacturers. The mine operated in this fashion until the late 1980s. The only published record of fluorspar production is 118,000 tons extracted between 1919 and 1961. The ore was ultimately extracted from 14 working levels along an inclined fault to a vertical depth of 560 ft. and along a length of 900 feet.

The final chapter of the mine took place in the early 1990's. A mining company began drilling exploration holes in the area west of the Fluorspar mine. They discovered a low-grade gold deposit, but not within the Fluorspar claim boundary. However, during exploration they did drill into an unknown pocket of fluorspar ore and Irving Crowell's grandson removed this last ore taken from this mine. Fluorspar had been an indicator of gold mineralization, but along the trend of the load instead of at depth. The gold mine operated from 1996 to 1999 and the remnants of the pit can be seen notched into the side of the mountain west (to the right) from Crowell's mine.

Fluorspar Mine, taken by Bob Adams, September 16, 2014

3 Upper Perlite Canyon
UTM 11N E0527476 S4083315
36.895416, -116.691620

You have now entered Perlite Canyon. The light gray, pink and white formations you see before you are airfall tuffs from the Rainier Mesa eruption of the Timber Mountain Caldera (11.6 m.y.a.). These fine particles of volcanic ash were deposited in horizontal layers while they were still warm. They stuck together as they cooled but maintained their particulate texture. As to the name of this canyon, the name perlite is given to rock made of small spherical particles of volcanic glass. It is sold commercially as a medium for plant growth. The layered tuffs in this area have subsequently been tilted and faulted along a low-angle gravity fault that has shifted them westward toward the present valley floor.

You have now left the older rock formations behind and are driving through one of the youngest eruptions in the area. These eruptions were not like the bubbling, fiery sprays that occur in Hawaiian volcanoes. These eruptions were explosive, boiling-gassy-cloud eruptions like Mount St. Helens. The source of this eruption, the Timber Mountain caldera, lies about 9 miles northeast of where you are now, split between the Nellis Air Force Range and the Nevada Test Site. For perspective, a geologist from the U.S. Geological Survey has characterized some of these eruptions as being 1000 times larger than Mount St. Helens.

A caldera is basically a collapsed volcano. After the magma explodes out of the ground, the surface area collapses into the emptied volcanic chamber creating a circular depression called a caldera. The diameter of the Timber Mountain caldera is roughly 12 miles.

Volcanic rock that is created from melting within the continental crust is more viscous than the melted sea floor rock found in Hawaii-- think toothpaste versus warm maple syrup. Because it doesn't flow easily, a tremendous amount of energy must build up to break the surface crust and allow the volcanic melt to escape. The viscosity also tends to encapsulate fluids and gases within the magma. Once the surface cracks, the force of the released magma and gases sends very hot particles of rock-- some fine like ash and some large like bombs- over a wide area very quickly. Pyroclastic flows, a mixture of burning gases and ash, can move at 60 miles per hour-- not something you can expect to out-run. This was the type of eruption that encapsulated the population of Pompeii in 79 AD.

These volcanic particles can solidify in different ways, and we will see examples of these along the route today. All the volcanic formations you will see today are Miocene in age (6 – 16 m.y.a.).


Upper Perlite Canyon Road, taken by Bob Adams, September 16, 2014

4 Alluvium
UTM 11N E0526220 S4086002
36.919673, -116.705624

At this point we are next to a basalt deposit-- the black ridge directly to your right. It is Miocene is age (10.5 – 11.5 m.y.a.) but is a more fluid type of magma that flows like a Hawaiian lava flow-- not like the explosive volcanics that dominate the area. It is younger than the volcanic tuffs we saw in perlite canyon, between 11.4 and 10.5 m.y.a.

As we continue down the alluvial fan to the Oasis Valley floor, you will see most of the rocks to the north (right side) are deposits of sand and gravel, not terribly interesting as they look just like alluvial fans everywhere. However, these gravels are old-- deposited between 11.5 and 4.5 m.y.a. They also hide a secret-- the Twisted Canyon caldera is buried under this gravel. A small caldera for these parts at only 2 miles in diameter, a pocket of buried magma burst forth creating localized deposits of tuff and lava about 11.55 m.y.a. However, the much larger eruptions of the Ammonia Tanks flows from Timber Mountain around 11.5 m.y.a. buried most evidence of this earlier eruption. The southern boundary of the caldera list just north (right side) of the road, and on the next leg of the trip up Beatty Wash we will pass over the northern edge of the caldera.

One other thing to notice in the alluvium is cementation. At this point if you look ahead on the south (left) side of the road you will notice the alluvium is standing very steeply, with some small cavity features near the top. Loose sand and gravel in an alluvial fan can become cemented by soluble minerals-- most often calcium carbonate-- that percolate with water through the pore spaces. Dry conditions cause the mineral particles to precipitate back into solid form, and over time these minerals fill in the pore spaces and re-create rock. In places where the flood channels have eroded against the alluvium, you may see steep embankments-- some practically vertical-- because the sand and gravel are cemented together. You may also spot small cubbyholes or overhangs in the alluvium where differential erosion has created mini caves. It is not unusual to find debris in these pockets because wildlife-- especially rodents-- take advantage of a protected area to store food and treasures or to build nests.

When you reach the highway, you will come to a gate. **[E0524178 S4087339 UTM 11S]** Please make sure the gate is secured behind you. For safety reasons, drive down the shoulder of the road to the next gate-- the speed limit is 70 mph here and traffic can be fast and frequent. Similarly make sure the gate into Beatty wash is closed behind you.

Alluvium and Basalt, taken by Bob Adams, September 16, 2014

Gate Beatty Wash Road
UTM 11N E0525062 S4088470
36.941952, -116.718543

As you start up Beatty Wash you will now travel along the north margin of the same older alluvial formation you crossed driving down the Perlite Canyon road, but you are headed into the young volcanic formations.

The Western Shoshone people lived in this area for more than 1000 years before the white man came. The generally warm and arid climate made survival a challenge, but the Shoshone adapted to the area by living in relatively small family units near reliable water sources and migrating seasonally with the food sources.

The most difficult period was early spring as winter caches became exhausted. During this time green plants and Joshua tree buds would be harvested in Beatty wash. By May and June, a variety of grasses would start to seed, and this provided a staple of the Shoshone diet. Lower elevations would ripen first, around Beatty and Oasis Valley, and progressively move to higher elevations up Beatty Wash and into the mountains. The native people would follow the food source, caching seeds when harvest was plentiful for future use.

By August seeds became scarce and the native diet would focus on small game like rabbits, chuckwallas or rats. Sometime family groups would join together to erect nets and spread out across the grasslands to drive rabbits into the net for a larger harvest. Hunting of bighorn sheep was also done in the mountains. In fall the pine nut harvest in the mountains provided a staple food source to carry the Shoshone through the winter.

5 Stonewall Flat Tuff
UTM 11N E0526312 S4088147
36.939007, -116.704516

Although we are surrounded by old alluvium, there is a nice outcrop on the right of a young rhyolite ashfall tuff that extruded 7.5 m.y.a. This was almost the last gasp of volcanic activity in the area after more than 10 m.y.a of nearly continuous-- and mainly explosive-- activity. This air-fall tuff is cohesive enough to stick together but can be broken apart with your hand. Because of its softness, it is only preserved in a few isolated locations around the Beatty area. At this location the bottom of the tuff lies directly on the alluvium.

Stonewall Flat Tuff, taken by Bob Adams, September 16, 2014

6 Rainier Mesa Tuff (welded)
UTM 11N E0529116 S4088996
36.946577, -116.672995

This canyon has made a nice slice down through the middle of the Rainier Mesa Tuff, one of several eruptions from the Timber Mountain Caldera. The tuff you see here is welded-- it is hard to break even with a hammer. The volcanic particles were still very hot when they were deposited here, and they became fused together into hard, brittle rock. Volcanic rocks are named for two attributes-- their mineral composition and the way the particles are attached to each other. The mineral composition of this unit defines it as rhyolite, just like the previous stop. But due to its texture, the last stop was an air-fall tuff while this unit is called a welded tuff. The volcanic material erupted during the Rainier Mesa episode totaled almost 450 cubic miles (1200 cubic Kilometers). It qualifies as a voluminous eruption.

As you drive ahead at about 0.1 miles you will see a lump of welded tuff on the south (right) side of the wash. This rock has been sculpted over time by the water and debris of flash floods. Flash floods can suspend a surprising amount of sand and gravel within the churning water, which makes it a very effective abrasive. That's why it is important not to drive into a flooded wash-- the water may not look that deep but you don't know how much of the floor of the wash has been scoured away by the churning, sediment-laden waters. Notice the potholes carved all the way through this hard rock by repeated floods-- this should give you some appreciation for the power of water in the desert.


Rainier Mesa Tuff, Welded, taken by Bob Adams, September 16, 2014

7 Rainier Mesa Tuff (columnar)
E0530442 S4090030 UTM 11N
36.955856, -116.658061

At this point the runoff has cut an impressive, deep slot through the Rainier Mesa formation over time. We are still looking at welded tuff, but the interesting thing about this location is the way the rocks cooled. A thick layer of hot melted rock was deposited here that took a long time to cool. The top area exposed to the atmosphere would start to cool first. As things cool, they tend to condense and shrink in total area. On the surface, cracks would develop as cooling progressed [it's a similar phenomenon to the development of mud cracks as they dry after a rain]. Gradually the rock would cool deeper and deeper into the ground, and the cooling cracks would propagate downward as well. With this convenient cross section through the formation, we can see these essentially vertical cracks formed columns in the layered tuff. This phenomenon is called columnar jointing. It is not as perfectly formed as jointing found in sites with more fluid lavas, like Devils Post Pile in California or Devils Tower in Wyoming, but it's still an interesting phenomenon.

Rainier Mesa Tuff, Columnar, taken by Bob Adams, September 16, 2014

8 Petroglyphs
UTM 11N E0530544 S4090747
36.962316, -116.656887

Native American rock art, also known as petroglyphs, is an ancient form of communication that is hundreds to thousands of years old. Unfortunately, some people do not respect the value of these artifacts to the Native American people or to human history. A rock art site lies near this location, but modern graffiti has been added to the site. Please honor the cultural heritage of Native American rock art and never deface an ancient site.

The geologic contribution to Native American rock art is the development of Desert Varnish. Over long periods of time-- up to thousands of years-- the surface of rocks in the desert develop a darker coating composed of clay minerals, iron and manganese. It is postulated to be the result of moisture and chemical weathering, but occurs over such a long period of time, its actual formative process has not been clearly proven. However, the phenomenon is purely external, so tapping through the surface reveals a contrasting, lighter colored pattern-- which the native people put to artistic use.

Petroglyphs, taken by Bob Adams, September 17, 2017

9 Silicon Mine (Tram Mine)
UTM 11N E0530680 S4091112
36.965602, -116.655344

This site was named Tram Ridge for the large tram system erected here. From the mine opening and ore bin high on the hill, a series of tram towers was erected, and a steel cable strung from the top of the hill to the processing station that was built on the ridge here before you. Despite the trouble and expense of tram construction, it had some advantages over wagon haulage. This site needed a very steep and winding road to access the mine at the top of the hill. The tram line can handle a steeper drop much more easily and over a shorter distance. In addition, the weight of the loaded ore buckets at the top drove the cable down by gravity and provided the pull to raise the empty buckets back up to the mine at the top.

There is a steep road to the top of the mountain that is called the China Road. The name suggests it was built by the Chinese. Trash at the site suggests occupancy occurred in the early 1900s.

A sizable mining camp existed at the site. With the name Silicon Mine or Thompson's Silicate Mine, one would assume that silica was the mineral produced. However, this is a common mineral and unless it had exceptional or very pure properties, it is doubtful that it would have been valuable enough to support the cost of the long-distance haul to market. Without more information we cannot speculate on the product from this site.

As you go to the north end of the road and turn back south to continue the course, look back toward the ridge top-- from this perspective you can see one of the tram towers still standing. From here the road will cross a ridge composed of the Rainier Mesa Tuff, then you drop down to the older alluvium formation.

When you reach the highway again, you will come to another gate [**E0525441 S4089098 UTM 11S]**. Please make sure the gate is secured behind you. Again, for safety reasons, drive down the shoulder of the road. As you approach the Hot Spring resort on the highway, you will turn eastward (to the right) through another gate [**E0525295 S4090300 UTM 11S]**. Again, make sure the gate is secured behind you.

From this point you will parallel the highway along a dirt road to avoid crossing private property. You will cross several alluvial washes on this leg of the course.

Once you leave the alluvium and start up the hill, you will cross onto a remnant of the younger eruption from the Timber Mountain caldera. This Ammonia Tanks eruption occurred 11.45 m.y.a and spread almost 350 cubic miles (900 cubic Kilometers) of volcanic material over the countryside. The bulk of this eruption is found on the Nevada Test Site and Nellis Airforce Range, and the source caldera is located about 16 miles east of this site.


Tram Mine, taken by Bob Adams, September 16, 2014

10 Kitty Litter Mine
UTM 11N E0525332 S4092096
36.974631, -116.715389

This area contains a clay that is particularly absorbent, and for a time it was mined for use as kitty litter. The clay is the product of weathering and/or alteration of the source volcanic rock.

Over those twin knobs at the top of the ridge and down to the bottom of the hill lies Bailey's Hot Springs. A depot was originally built here as a watering stop for the Bullfrog and Goldfield Railroad during the booming days of the Bullfrog gold rush. As we proceed north and drop down off this hill, we will drive on a portion of this historic railroad grade which began operations in June 1907.

After the Bullfrog boom busted, the Tonopah and Tidewater Railroad leased the B&G tracks to be able to operate their trains all the way to Goldfield. The T&T operations were kept afloat primarily by borax production east of Death Valley until 1928 when the mines closed. Talc mines and the local fluorspar mine continued to provide meager business for the railroad, as did shipment of construction supplies for Scotty's Castle in northern Death Valley. The T&T had tried to support train operations by developing tourism to mysterious Death Valley and the newly- constructed Furnace Creek Inn (which opened February 1927), but with little success. Operations were suspended on June 15, 1940 and two years later the rails were removed for use in the war effort.

By the way, the Beatty Hot Springs are not hot due to volcanic activity. Rather, this water has percolated deep underground through permeable rock units or rocks that have broken by faulting or folding. The deeper you go into the ground, the higher the thermal gradient-- very deep mines often must pump chilled air underground in order for men to be able to work. The average geothermal gradient is 1° Fahrenheit per 70 feet of depth, but in areas of volcanic activity, the temperature rises faster. The waters that emit from these springs have been a few thousand feet below ground before returning to the surface at a temperature of 100+ degrees.


Kitty Litter Mine, taken by Bob Adams, September 16, 2014

11 Spicer's Junction
UTM 11N E0524541 S4094397
36.995394, -116.724201

This concludes the eastern loop of the off-road tour. You will need to cross the highway and travel down the shoulder of the highway to Pioneer road to continue the course.

12 Crystal Spring Road
UTM 11N E0524511 S4093586
36.988085, -116.724565

As you leave Highway 95 and drive up the wash, the hills you pass through are composed of landslide breccias. Breccia is a rock composed of angular fragments of older rocks melded together. These formations contain blocks of Miocene (23.0 to 5.3 m.y.a.) rhyolite tuffs and lavas and Precambrian (>541 m.y.a.) quartzite and marble. They exist as a mixture of landslides, talus (produced by rockfalls), avalanche breccias and mega-breccias. Cumulatively these are the result of major fault activity in the area that occurred from 11.4 to 10.0 m.y.a. These units are broken by normal (down-dropped) faults, low-angle gravity faults and trans-located along strike-slip faults. In some places, large blocks of Cambrian rocks (more than 490 m.y.a.) lie atop 11 m.y. old volcanic rocks. It is hard to envision processes that could so dramatically rearrange the surface landscape.


Crystal Springs, taken by Bob Adams, July 9, 2019

Station 13 Pioneer and Mayflower Mines
UTM 11N E0518922 S4094294
36.994596, -116.787351

This pocket valley contains two prominent mines of the Bullfrog Gold Rush era. During detailed mapping of the area in the 1960s it was postulated that a large caldera (some 12 miles in diameter) underlies the entire Bullfrog mining district. Three of the largest gold producers, the Montgomery-Shoshone, Mayflower and Pioneer, lie along the eastern margin of that caldera. Most of the projected caldera is buried by alluvium, but the exposed bedrock formations are interlaced by normal faults, and this certainly facilitated the movement and deposition of precious metals by hydrothermal mineralization like that seen in Fluorspar Canyon.

Rhyolite tuffs and lavas dominate the center of this valley while landslide breccias form the periphery. There is an area on the east (right) side of the basin where Precambrian quartzite and marble is also exposed.

As the good ground in the Rhyolite area was staked in the early 1900's, prospectors moved out into surrounding areas to find their own gold mine. Gold was discovered in 1907 in the Pioneer mine, which is located on the north side of the basin (across the valley). By the end of 1908 a substantial camp had built up between the Pioneer and Mayflower mine (which lies ahead along the road). A town of about 1000 people included a number of small businesses, it's own newspaper and by March 1909 its own post office. The boomtown was short-lived as a fire in May of that same year burned most of the town to the ground.

If you were too late to stake a good claim, another way to try to make money was to accuse a neighboring mine of tunneling into your claim and removing your gold. The basis of American mining law goes back to European mining practices in the 1500s. It was observed that precious metals were often found in quartz veins or fault zones that were generally linear along the surface of the ground. However, when followed down into the ground, they often formed an inclined slope. For this reason, if you staked your claim on the ground, as you followed the ore downward, it would gradually move out of your claim into adjacent ground. Someone else could lay out a claim next to yours, and at depth your vein became theirs. So mining law was written so that the down-sloping continuation of a vein staked at the surface remained in the ownership of the original discoverer-- it was called the apex rule or the rule of extralateral rights. The only problem is that it is sometimes hard to follow a vein underground precisely, and sometimes the ore isn't in a vein at all. This opened the door to charges of claim jumping. Much effort was required to develop proof on the ground, and time in court to convince the judge to clear the title to the ore in question.

In the spring of 1909 the owner of the Indiana claim, a man named Millikin, accused the Pioneer mine of removing ore from his claim. A visiting mine engineer named Swart toured the Pioneer mine during this time.

The ore exposed on the first level was 100 ft. long by 45 ft. wide; the second level essentially the same dimensions, and the ore zone on the third level as 70 ft long by 20 ft wide. It was speculated that the Pioneer's ore ran $100 to $200 dollars per ton-- which at gold prices in that day would translate to 5 to 10 ounces per ton of ore. To process the ore, the Pioneer had a 5-stamp mill to pulverize the ore, mercury amalgamation to recover the coarse ore particles, and cyanide leach tanks to recover any fine gold.

This visiting engineer also made a drawing of the two properties in question. From his drawing (seen here) it was obvious that the vein of ore being mined by the Pioneer owners apexed on their claim. However, the owner of the Indiana claim took the position that this was not a vein at all and therefore did not give them extralateral rights. Convinced that the ore being mined from the Pioneer shaft belonged to him, the owner was feverishly sinking a shaft to intersect the ore zone at depth. He needed evidence to bring his accusations to court.

A visiting engineer in 1914 reported the outcome of this controversy: after long and expensive litigation, the owner of the Indiana claim had to give the owners of the Pioneer claim his feverously constructed shaft that accessed the Pioneer's ore deposit. As of 1914 the Pioneer had produced some $500,000 in gold. According to modern records the last ore was taken from the Pioneer mine in 1940.

Engineer Swart also got a tour of the Mayflower operations in 1909, and he described the milling process in detail. The ore fed into a 7 x 10 ft Blake jaw crusher which broke the ore into gravel sized pieces. The crushed ore was next fed into a 5-stamp mill, where heavy metal cylinders pounded the gravel to sand size. The sand then flowed as a slurry down a gently- sloping table covered by a mercury-coated copper sheet. Gold and silver adhered to the mercury while the sandy rock debris flowed off the end of the sheet.

The sandy slurry next flowed by gravity to tanks that contained sodium cyanide solution. Next, the slurry would be agitated in the tank for a period of time to allow any remaining gold to be dissolved in solution. Then, the solution was then pumped to a processing tank to reprecipitate the dissolved gold and silver. The sandy slurry was then pumped to a tailings pile which would become its final resting place.

Periodically the stamp mill would be stopped, and the mercury would be removed from the copper sheet. It would then be heated in a retort oven. The vaporized mercury would be recovered and cooled back to liquid form to be reapplied to the copper sheet. The gold-silver ore' left by the vaporized mercury could then be melted into bars, assayed for precious metal content and sold, or sent to a refinery for sale.

Although the processing equipment was removed long ago, there is a large concrete foundation uphill from the wooden ore bin that is a possible location for the jaw crusher. This was a heavy piece of equipment that would require a sturdy foundation.

A historic photo (see following page) of the Mayflower mill was taken from the hillside behind the ore bin. It shows a trestle that would have conveyed the ore to the mill building adjacent to and slightly higher than the ore bin, which is still standing today. The stamp mill was located below the ore bin so the ore could feed by gravity to be pulverized. This heavy equipment also required a sturdy foundation. The sandy slurry from the copper plates would have flowed into cyanide tanks on the level below the stamps. Some of the discarded dark-reddish sandy tailings from the cyanidation process can still be seen on the south side of the hill below the mill site.

Note that lighter-colored cyanide tailings can also be seen across the road below the Mayflower mill. These tailings are the remnant of much more recent milling operations, as is the yellow ore shoot that once fed a crusher on the hill north of the historic mill site. These tailings have perforated PVC pipe exposed at the bottom – a material not available in 1909 and one commonly used in gold milling operations in the late 20th century.

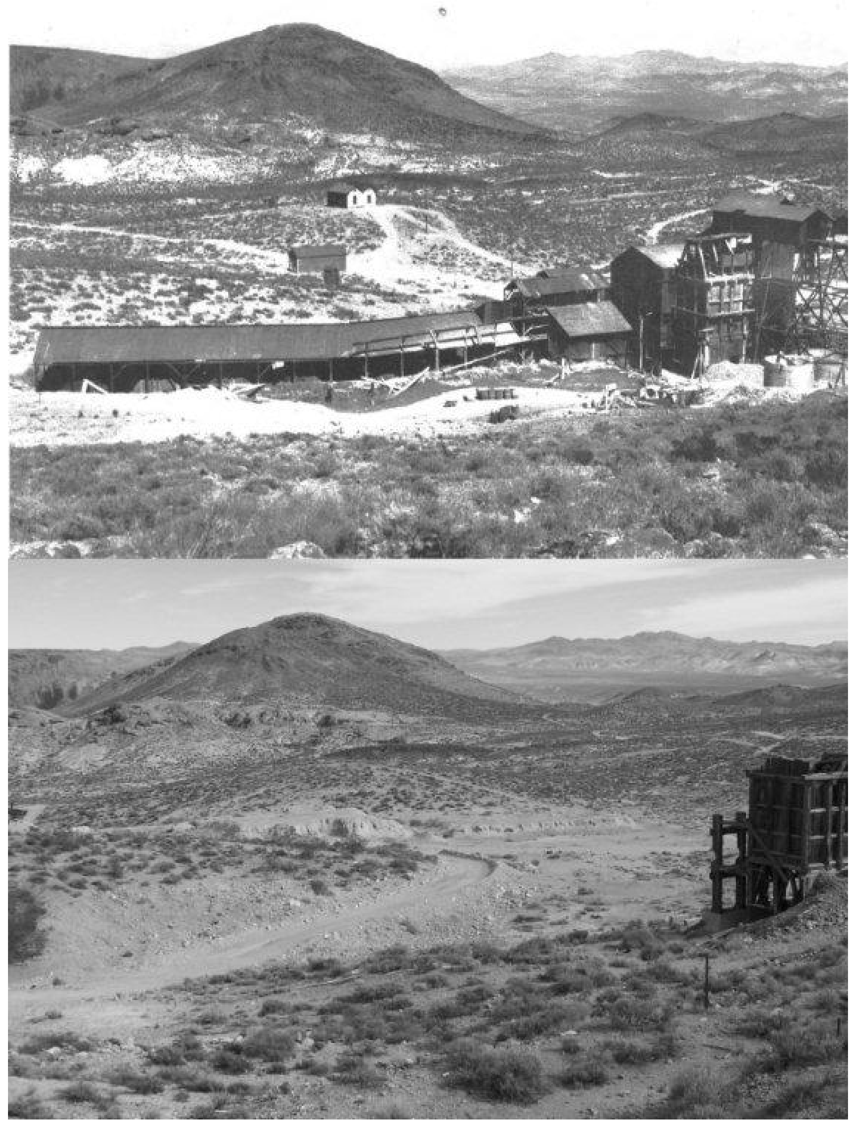
If you want to wander around the site, be aware of mine openings. Oxidation and weathering of ground around mine opening causes instability and the possibility of collapse. Wooden structures also don't hold up well in the desert. Avoid all mine openings for your safety.


Mayflower Mine, taken by Bob Adams, July 6, 2016


Pioneer Mine, taken by Bob Adams, July 6, 2016

Pioneer Road, taken by Bob Adams, September 16, 2014

From: American Zinc Co., Walter G. Swart Files, Nevada



Upper photo historic photo; Lower photo modern
view from same perspective.
Photo from the O'Brien collection

To return to the course, drive back down the Pioneer road to **E0521934 S4093643 UTM 11S** and turn south (right) onto the road to Crystal Spring.

14 Crystal Spring
UTM 11N E0521382 S4093241
36.985051, -116.759735

This spring was the source of water for the mines and residents of Pioneer. The fence surrounds the subsurface spring area and was installed by the BLM to protect the water supply from contamination by burros. Water would have been pumped from here over the hill and into the Pioneer basin.

There is an old ranch house below the spring area. Cattle ranches existed in Oasis Valley prior to the mining booms. The presence of a good water supply here may have enticed a rancher to settle in this valley.

When you leave Crystal Spring, you will gradually climb out of the valley. As you near the top of the ridge, the road becomes steep and rocky. You are driving on the old freighting and stagecoach road that ran from Rhyolite to Goldfield and Tonopah-- major gold and silver mining towns in western Nevada. At the top of the pass you will see a wide wash that drains the Bullfrog hills.

This is Sober-up Gulch and it marks a change in geology. As you cross this wash, you leave the region of landslide breccias behind. You are now entering terrain dominated by rhyolite volcanics that were erupted 10.4 to 10.5 m.y.a. They consist of interlayered Rhyolite Tuffs (explosive flows) and Lavas (fluid flows) named for Rainbow Mountain, which we will pass up ahead. These units are younger than the volcanic rocks seen on the eastern side of the highway. Directly adjacent to Sober-Up Gulch on the northwest (right) side of the road is the Trachyte of Donovan Ridge which followed the Rainbow mountain eruptions 10.3 m.y.a. You will also see several mining prospects as you drive south toward Rhyolite. Prospectors sank shafts or drove adits into any promising outcrop.

All these rocks are broken by normal faults, which is characteristic of the terrain in the Basin and Range province. These landforms cover all of Nevada, Utah and parts of California, Arizona, Idaho and Oregon. The region is characterized by parallel mountain ranges and valleys created by normal faults and tilted rock layers. This landform is indicative of a time when the continent was expanding in response to plate tectonic motion.

The Great Basin is a region within the Basin and Range and covers almost all of Nevada. It is given this name because no water flows out of it. All rainfall evaporates on the valley floors, or percolates into the ground as subsurface flow. So, like Las Vegas, what rains in the Great Basin, stays in the Great Basin!

Since a large portion of this area generally receives low amounts of rainfall-- Beatty averages 4 inches per year, Death Valley averages 2 inches-- most of the water usage comes from groundwater that was rainfall hundreds to thousands of years ago. Some groundwater might even have originated from glacial melting which began about 11,000 years ago. However, age dating of groundwater is complicated by chemical interaction with the rock formations, so some reported ages are suspect. Whether the water is hundreds or thousands of years old, it has been in the ground a long time. If desert residents are not careful about their use of water resources, they could render this arid region uninhabitable-- you can't live without water!


Crystal Springs, taken by Bob Adams, July 9, 2019

15 Indian Springs
UTM 11N E518153 S4088557
36.942895, -116.796131

Here we see another fenced area enclosing Indian Spring. This was the first major water source for the town of Rhyolite and provided water until the last resident passed away in the 1980s. In the early days of Rhyolite, the only reliable source of water was the springs on Old Man Beatty's ranch, located about a mile east of the town named for him. Water could be had for as much as $5.00 a barrel, and sometimes it was flavored by the whiskey the barrels had formerly contained.

A water line was completed from Indian spring to Rhyolite at the end of July 1905. The water flowed into two 20,000-gallon reservoir tanks. A barrel of water could be delivered to your door by wagon for the bargain rate of $1.50. During that summer more than 30,000 feet of water lines were installed to service 34 town blocks. Upon completion later that year, residents could purchase metered water for 1¢ per gallon.

During the summer of 1905 two other enterprising companies developed water lines into the Rhyolite area. One group developed springs from Oasis Valley some 10 miles north of the town of Beatty. This water could flow by gravity via a 7-inch pipeline into the town of Bullfrog located SSW of Rhyolite. It was designed to be able to supply water to a proposed mill. Meanwhile the Patrick brothers purchased Beatty's Ranch and collected water from some 13 springs. A 4 ¼ inch water line was laid 5 ¼ miles to a storage tank on Bonanza Mountain west of Rhyolite. The water line paralleled a portion of the railroad right-of-way of the Las Vegas & Tonopah Railroad which began operation into Rhyolite in December 1906. By August 1907 all three water companies agreed to uniform water rates of 1¢ per gallon for the first 1000 gallons, 1/2¢ per gallon for the next 4000 gallons and 1/4¢ per gallon for any additional gallons.

Indian Springs, taken by Bob Adams, October 2, 2014

16 Rainbow Mountain
UTM 11N E0515932 S4087689
36.935111, -116.821093

As we reach this pass, we are facing a valley that separates two geologic units. Rainbow Mountain lies on the east (left) side of the road-- the same rhyolite we've driven through since crossing Sober-Up Gulch created (and is named for) this mountain. These 10.5 – 10.4 m.y.a. old rhyolite tuffs and lavas erupted from vents somewhere in the eastern part of the Bullfrog Hills that lie to the west (right).

The rocks that make up Busch Peak on the west (right) side of the road, however, are the older rhyolite tuffs seen in Beatty Wash on the other side of the highway. Rainier Mesa tuffs (11.6 m.y.a.) are interlayered with Ammonia Tanks tuffs (11.45 m.y.a.) due to faulting. Both units are predominantly rhyolite. Both units were erupted from the Timber Mountain caldera some 19 miles NE of where we are now. A normal fault passes through the middle of this valley over a distance of at least 18 miles and offsets these two geologic terrains.

Indian Springs, taken by Bob Adams, September 16, 2014

17 Montgomery-Shoshone Mine
UTM 11N E0515677 S4085752
36.917654, -116.823996

At this point, you can see the historic Montgomery-Shoshone Mine, largest gold producer in the Rhyolite district, on the east (left) side of the road. Bob Montgomery had been unsuccessful during his prospecting trip in the summer of 1904, but before he returned home, he grubstaked a young Shoshone named Hungry Johnny. When he returned, he found Johnny had staked what looked more like a talc mine than a gold mine. But one sample ran $300 a ton in gold! The Montgomery Shoshone ultimately became the most productive mine in the district producing $1,344,000 of the $1,886,000 produced from the entire district up to 1948.

The price of gold in the 1980s again stimulated interest in the district. In 1988 Bond Gold reopened historic mines using surface mining techniques. Successive operators ultimately excavated the old underground Montgomery Shoshone mine and the Senator Mine area on Ladd Hill by open pit. They even drove a tunnel in the bottom on the pit to access rich ore underground. The mine operated until 1998 and produced about 690 thousand ounces of gold.

From this point the open pit highwall is along the skyline of the hills. Underground mine workings were exposed at places during the surface mining operations. In the foreground of the hill is the mine waste dump where non-ore-bearing rock was discarded during operations. After mining was completed, the surface was graded to a more natural appearance, covered with topsoil and seeded to develop natural vegetation. This would reduce the chance of excessive erosion.

Continue driving ahead on this road to intersect the main street through Rhyolite.


Montgomery-Shoshone Mine, taken by Bob Adams, September 16, 2014

Montgomery-Shoshone Mine, taken by Bob Adams, September 27, 2017

18 Rhyolite Depot
UTM 11N E515243 S4084175
36.903445, -116.828900

You are now at the historic railroad station for the Las Vegas and Tonopah Railroad. A guidebook is available at this point for your use. There are a variety of historic sites to see in Rhyolite. Enjoy the area at your leisure. As always in a historic mining area, be cautious around any mine workings.

Gold was discovered by Shorty Harris and Ed Cross at the Original Bullfrog mine in the summer of 1904. After staking their claim, they went to Goldfield where the first ore sample assayed $665 per ton-- and that with gold selling for $20 per ounce. As word spread, the rush was on. Their claim lay almost 3 miles west of where the town of Rhyolite would be established, but the town was centrally located among the other gold mines discovered.

Just like the mineral deposits we've seen at the previous mines; the Rhyolite mines were formed by hydrothermal mineralization. Gold and silver were deposited where hot waters percolated along faults, causing varying degrees of alteration and precipitation. Geologists who examined the district in 1907 and had access to the tunnels and shaft at that time described the characteristics of the ore-bearing zones.

Most of the mineralized zones observed were steeply oriented fault zones, often containing a few to several mineralized stringers within rhyolitic host rock. Zones were filled with quartz or calcite and sometimes associated with gold-bearing pyrite. In places the pyrite would be oxidized to limonite, a brownish clay-like material that would contain specks of free gold. Notably in the Montgomery-Shoshone mine the rhyolite was strongly altered to a white clay, while the Original Bullfrog mine had an abundance of crystalline and chalcedonic quartz. Some deposits also showed trace amounts of copper minerals associated with the ore. Gold was the consistent ore mineral present, but silver occurred in varying amounts around the district. Some deposits had intersecting basalt dikes in proximity to ore zones. One such zone in the Montgomery-Shoshone mine ran 60 feet wide and averages $700 per ton, or almost 34 ounces per ton of ore.

So, the presence of fractures to allow fluid flow was always a factor in the presence of ore in the Rhyolite District. The chemical reactions varied between deposits with quartz, calcite, iron (pyrite) and possibly basalt playing a roll. In some places copper was also present. The only other observation noted was that most of the faults showed 100 ft of displacement or less. However, the Montgomery-Shoshone fault show as much as 2000 ft of displacement. This may have been a factor in the size and ore grade of this deposit over all the rest of the mines in the district.

When you have finished with your time at Rhyolite, return to the railroad station and follow the historic LV&T railroad grade back to Beatty and the VFW Post.

19 Water Lift Station
UTM 11N E0518654 S4084258
36.904132, -116.790611

At its peak it was estimated that 4000 people called Rhyolite home, so demand for water (and the resultant price) was initially high. As earlier noted, one of the water lines that served Rhyolite was built by the Patrick brothers along a portion of the railroad right-of-way. A 4 ½-inch water line was constructed from the springs at Old Man Beatty's ranch into Rhyolite during the summer of 1905. At this site a lift station operated to raise the water flowing from Beatty over the divide and into the Rhyolite basin.
From this point follow the road back to your staging area.

Subject: - Surface structures and trucks at Crowells' Fluorspar mine located on Bare Mountain east of Beatty, Circ 1928. The surface structures belie the mine's extensive Underground workings and its long record of production and Of providing employment to Beatty area miners.
The truck on the left is a Model-T; the other is a Model-A.
Nye County Town History Project – Crowell Collection

Subject: - Joshua Irving Crowell in his dugout dwelling at his Chloride Cliff mine, Funeral Mountains, Beatty, Nevada. Judging from the date on the calendar in the background, this photograph was taken October 12, 1915.
Nye County Town History Project – Crowell- Collection


Water Lifting Station, taken by Bob Adams, September 16, 2014