GL02055

GEOLOGY AND MINERAL RESOURCES
OF
TOWNSHIP 27 NORTH
RANGES 31, 32 AND 33 EAST
MOUNT DIABLO MERIDIAN
PERSHING COUNTY, NEVADA

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INTRODUCTION

Township 27 North, Ranges 31, 32 and 33 East, Mount Diablo Meridian, is situated in Pershing County, Nevada. The Southern Pacific Company serves Lovelock (in Twp. 27N., Rge. 31E.) and the surrounding vicinity with main line railroad facilities. U.S. Highway 40 and the rail line connect Lovelock with Reno, approximately 70 miles west.

TOPOGRAPHY AND ACCESSIBILITY

The topography, road system, trails and accessibility are shown on geologic map No. R-31,32,33-27. The regional setting may be ascertained by inspecting the U.S. Geological Survey topographic sheets of the Lovelock Quadrangle (1931) or the Lovelock Quadrangle, 1:62,500 scale (in preparation) and the Buffalo Mountain Quadrangle, 1:62,500 scale (1954).

CONCLUSIONS

Twp. 27N., Rge. 31E.

Company Ownership

Sections - 19 (part), 21 (part) and 31 (part).

Section Evaluation Summary

Section - 19 (part) . . . . Decomposed granite (grus) in E½ and SW¼.

Section - 21 (part) . . . . Nonmineral. Could be developed into marginal agricultural land.

Section - 31 . . . . Nonmineral.

Twp. 27N., Rge. 32E.

Company Ownership

Sections - 1, 3, 5, 9, 11 (part), 13, 15, 19, 21, 23, 25, 27 (part), 29, 31, 33 and 35.

Section Evaluation Summary

Sections - 1 and 3 . . . . Nonmineral.

Section - 5 . . . . Nonmineral. (1) Possible industrial site; railroad and highway traverse section, water available. (2) Parts of section could be developed into agricultural land.

Section - 9 . . . Nonmineral. Possible industrial site.

Section - 11 (part) . . . Small quantities of impure clay derived from altered rhyolite tuff - no economic importance. Occurrence of a thin quartz vein with poor copper mineralization - no economic importance.

Section - 13 . . . Nonmineral (limited limestone occurrences).

Section - 15 . . . Numerous limestone occurrences.

Section - 19 . . . Nonmineral. Possible industrial site; 1/2 mile from rail and highway facilities - water available.

Section - 21 . . . Gravelly beach terrace deposits suitable for aggregate, 4 miles from Lovelock. See Section Report.

Section - 23 . . . Occurrence of small ferruginous breccia zone in limestone - noneconomic.

Section - 25 . . . Occurrence of thin quartz veins with minor copper mineralization, SE¼ - noneconomic. Minor limestone occurrences.

Section - 27 (part) . . . Nonmineral (minor limestone occurrences; possible anhydrite beds at depth).

Section - 29 . . . Nonmineral. Possible gypsum mill site.

Section - 31 . . . Nonmineral. Possible industrial site.

Section - 33 . . . Impure silty-clayey lagoonal deposits suitable for construction purposes - NE¼. Impure secondary gypsum deposits S½. See Section Report.

Section - 35 . . . Occurrence of poorly mineralized quartz bodies and veins in S½ofSE¼. Adjacent Sec. 2 (Twp. 26N., Rge.

32E.) has gold, silver, lead, copper and antimony mineralization in quartz veins (Muttleberry Mine - see Danehy, 1957). In SW¼ high grade gypsum deposits (limited volume) in SW¼ associated with crystalline limestone. See Section Report.

Twp. 27N., Rge. 33E.

Company Ownership

Sections - 1, 3, 5, 7, 9, 11 (part), 13 (part), 15 (part), 17, 19, 21, 23, 25, 27, 29, 31, 33 and 35.

Section Evaluation Summary

Sections - 1, 9, 17, 19, 21 and 23 . . . . Nonmineral.

Section - 3 . . . Minor limestone occurrences, disseminated cinnabar occurs in limestone extending southward to the Paymaster prospect.

Section - 5 . . . A small acidic dike with minor quartz veins; no metallic mineralization observed - noneconomic.

Section - 7 . . . Small quantities of impure, low grade clay derived from volcanic material - noneconomic.

Section - 11 (part) . . . Vugs in limestone filled with iron-stained calcite. Antimony mineralization in limestone is reported from this section.

Section - 13 (part) . . . Favorable conditions for cinnabar occurrences may exist in NW¼ as the southeast extension of deposits (Paymaster) in Sections 11 and 14.

Section - 15 (part) . . . Possibility of antimony associated with quartz veins.

Section - 25 . . . Nonmineral. Subsurface water available.

Sections - 27, 29, 31 and 33 . . . Nonmineral. Tertiary volcanic rocks underlie all or parts of these sections - could include pumice or clay deposits, although no economic deposits are known in this particular part of the volcanic terrain.

Section - 35 . . . Nonmineral. Possible subsurface water along Packard Wash.

MINERAL RESOURCES-EXAMINED

Twp. 27N., Rge. 31E.

Metallic Deposits

None known in township.

Nonmetallic Deposits

None known in township.

Construction Materials

Granitic Sand - Sections 20, 29 and 30

Fine layered granitic sand with a varying amount of gravel forms a thin veneer (generally only a few feet thick, but locally in Sections 20 and 29 amounting to more than 30 feet) over parts of Sections 20, 29 and 30.

The upper 15 feet of this light yellow, fine-grained granitic sand contains layers of small boulders, pebbles and fine gravel derived from the rhyolite flow that caps Lone Mountain. A substantial part of the sand deposit has already been used for local construction purposes.

Sections 29 and 30 could yield small quantities of similar sandy material, although probably only in Sections 20 and 29 is there sufficient volume to have significant economic value.

MINERAL RESOURCES-EXAMINED

Twp. 27N., Rge. 32E.

Metallic Deposits

Silver-Lead

Muttleberry Mine Area (Sec. 2, Twp. 26N., Rge. 32E. and Sec. 35 Twp. 27N., Rge. 32E.) In the S½ofSE¼ of Sec. 35, Twp. 27N., Rge. 32E., there are a number of small prospects north of the Muttleberry Mine (Sec. 2, Twp. 26N., Rge. 32E.). Sampling of quartzose material from one of these prospects produced the following low value assay results:

Sample R-35-27-32-2 Ch (a)

Gold	None
Silver -	0.05 oz. per ton
Antimony . . .	None

A composite high grade sample (Danehy, 1957, p. 5) from the various workings of the Muttleberry Mine returned a much more favorable assay result:

Sample R-02-26-32-1 Dn (a)

Gold	0.010 oz. per ton
Silver	35.2 oz. per ton
Lead	1.0 per cent (wet)
Copper	0.60 per cent
Antimony	2.2 per cent

The values reported above are probably not representative of mine-run material since if they were the property would be in production.

The mineralization seems to be associated with quartz stringers and the various dikes that cut the metasedimentary rocks. There are aplitic-like dikes of light colored equigranular rocks with disseminated pyrite. The rock is considerably altered and is now calcareous enough to effervesce slightlywhen acid is applied. There are also coarse breccia dikes of altered angular pieces of greenish or yellowish siliceous rock in a calcareous yellowish colored matrix. Quartz stringers and small pyrite cubes are locally abundant. In some places relic shaly or slaty cleavage is discernible in the larger (up to 3 inches large in diameter) breccia fragments.

As the mineralization seems to be associated with the igneous dikes, additional sampling and detailed mapping in company Sections 35, Twp. 27N., Rge. 32E. and Section 2, Twp. 26N., Rge. 32E. might furnish more information concerning the occurrence and composition of the ore. However, judging from the history of the district (see Danehy, 1957, p. 5), it is doubtful if economic ore bodies could be located and developed. Therefore, the expenditure of additional time and monies is not warranted.

Quartz Veins with Copper Mineralization

Prospects - Sections 11 and 12. A number of northerly trending quartz veins, generally 4 inches to 3 feet thick and locally up to 10 feet thick, traceable many hundreds of feet, are associated with rhyolitic sills in the E½ of Section 11 and the extreme W½ of Section 12. Copper mineralization (chalcopyrite and tetrahedrite) is meager in the white quartz and no mineralization was found in the rhyolite. Trenching and small open cuts expose the veins at different places. Sampling and assaying (Durkee, 1919) disclosed that the character and quantity of the ore was not very favorable and the occurrences were classified as very poor prospects.

Prospect - Section 12. A small prospect pit near the road in the center of Section 12 discloses a 7 ft. wide outcrop of white quartz. The vein was not traced in the metasedimentary rocks either east or west of the road. No metallic mineralization was observed, but presumably small silver and gold values are present.

Prospects - SE¼ofSE¼ of Section 25. A small shaft and a shallow prospect pit expose copper stained quartz veins up to two feet thick in limestone and metasediments. The 20 ft. deep shaft was sunk on a vein one foot or less in thickness that strikes N05°W and dips 35° SW. A 10 foot long drift to the southwest exposes disseminated chalcopyrite (?) in the quartz.

No samples were taken because it seemed a very poor prospect. Sampling by Stoddard (1917) assayed a trace of gold and silver.

Iron

Quartz - No. 1 claim, Section 23. A small prospect at the northern edge of Section 23 exposes a ferruginous breccia (?) zone in white limestone. At the point indicated on the map, a six feet thick outcrop of iron-rich material strikes N 70 W and dips 70 SW. Calcite veins and vugs filled with calcite are present. No quartz was observed. The prospect was "claimed" in 1953.

Similar occurrences in Twp. 26N., Rge. 32E. (Danehy, 1957) failed to show any significant mineral value.

Nonmetallic Deposits

Twp. 27N., Rge. 32E.

Lovelock Gypsum Deposits

Bedded gypsum crops out in the Humboldt Range east of Lovelock in Sections 22, 27, 28, 33, 34 and 35 of Twp. 27N., Rge. 32E. The main deposits in Sections 22, 27 and 28 were known long before the end of the 19th century. Louderback (1904a, p. 112-118) records production in 1891-

1893 for shipment to plaster mills on the West Coast. Production of the early 1900s went to the Western Gypsum Company mill at Reno, Nevada. These early developments were abandoned because of the difficulty of producing a product of desirable purity from these low-grade deposits.

The various occurrences were considered and reconsidered by various companies during the period 1911 to 1939, but little or no mining or real development work was done. In 1939 U.S. Gypsum optioned a significant block of land and subsequently core drilled and tested their part of the deposit. Results were encouraging enough so that the options were exercised, lands involved were patented, and plans were formulated for a complete gypsum plant to be constructed on Section 17. World War II and the purchase of the Empire (Gerlach, Nevada) gypsum plant of the Pacific Portland Cement Company resulted in shelving of the Lovelock development.

Currently (1957), the main deposits in Sections 27 and 28 are held by U.S. Gypsum and the Fibreboard Paper Products. Each firm controls approximately half of an estimated 25 million ton reserve of gypsum.

Geology. The gypsum deposit at the surface consists of high grade, white to gray, granular, efflorescent gypsum. Locally, iron-oxide stains the deposits, and in places there are small flecks of yellow crystalline sulphur, but on the whole the surface deposits give an impression of fairly high purity. At depths greater than 5 feet, a few limestone beds are intercalated with the gypsum. Drilling has shown that the deposits grade into anhydrite at a depth of 70-140 feet. The entire deposit was probably originally anhydrite. The occurrence of the limestone reduces the over-all average purity to approximately 77% gypsum. The main deposit in the W½ of Section 27 and the E½ of Section 28, and a smaller deposit in Section 22, are bounded by blue-gray limestone beds.

The structures involved are very complex. The gypsum beds themselves rarely show reliable attitudes because surface hydration has destroyed original sedimentary features, but the directly adjacent limestone beds may be mapped with a fair degree of accuracy. The main deposits seem to be bounded on all sides by faults. Subsurface information (Havard, 1957) indicates that the area is part of an overthrust of an overturned fold. This interpretation is substantiated by similar thrust relationships mapped and described by Danehy (1957) in the adjacent area to the south. The economic significance of the overthrust relationship is that it means the deposits are extremely variable in depth and that they may not have bed extensions in the immediate area; therefore, it is very unlikely that extensions of the deposits will be found on Southern Pacific Company lands or other land at depth or in the adjacent area.

Present information suggests that the overthrust was from a westerly direction. The downdropped basin block to the west is largely covered with Tertiary deposits and Quaternary surficial deposits. Therefore, if the gypsum deposits of the lower plate of the thrust are to the west, they are probably buried at considerable depth and their location is not easily determinable.

Some of the early production came from quarries in Section 22. The gypsum here is associated with dark blue-gray, locally conglomeritic limestone and a sequence of reddish purple shaly rocks. Structurally, the gypsum lies in an overturned syncline. A northeast trending cross fault bounds the economic deposits on the north side.

The gypsite occurrence in the NE¼ of Section 33 seems to be a redeposition of gypsiferous material derived from the main deposits of gypsum to the northeast. There is considerable admixture of limestone and shale fragments with gypsum. Prospecting has indicated a maximum known thickness of less than 10 feet and an average thickness of about 4 feet. Catlin (1923, p. 2) estimated that the deposit might contain some 16,000 tons of earthy, impure gypsite suitable for agricultural uses, or possibly for construction materials if the material was developed, mined and beneficiated along with gypsum from the main deposits. Simons (1950) examined the property and reported that there might be 3000 tons of gypsite suitable for local agricultural use.

There are two occurrences in Sections 34 and 35 separated by a small valley. The gypsum overlies white limestone that seems to have a synclinal form. However, the limestone is in every way similar to the thrusted limestone known to the south (see Danehy, 1957) so the subsurface relationships are very uncertain. Assuming a shallow synclinal occurrence, the western part of the deposit is estimated to contain approximately 6400 tons of gypsum and the eastern part approximately 4000 tons.

These deposits are not large enough to be worked by themselves, but the material they contain may be utilized when the other Lovelock gypsum deposits are developed.

Limestone

Thin limestone beds are widespread throughout the bedrock area of Twp. 27N., Rge. 32E. A considerable quantity of high calcium limestone will of necessity be mined with the gypsum of the Lovelock deposits. Perhaps it will be profitable to recover the limestone as a by-product and, if so, other limestone deposits in the area might receive some attention.

Most of the limestone beds mapped range between 10 feet and 25 feet in average thickness.

Section 15. Limestone ridges traversing this section are thought to be the same beds that have been repeated by faulting. The beds here are approximately 20 feet thick and, in general, dip eastward at a moderate angle. The area is about 2½ miles from the railroad. There are numerous other more favorable deposits of limestone in this general region of Nevada, but this is the most extensive deposit on Southern Pacific lands in the immediate area.

Section 35. Some white limestone is associated with gypsum in this locality.

Halloysite (?) Clay in Section 2 and in NW¼ofNE¼ of Sec. 11, Twp. 27N., Rge. 32E., MDM.

Clayish material is found in the vicinity of Sections 2 and 11 where rhyolitic tuff has been irregularly altered to halloysite (?) clay. Dumble (1921) brought initial attention to the deposits when he reported halloysite present in large quantities. Interest surged again in 1928 and then in 1941. Examinations by Catlin (1921), Mack (1941), and the current investigation failed to show any significant deposits on Section 11, although more favorable appearing occurrences are present on Section 2.

The acidic tuffs commonly weather to an impure clayish material at the surface of outcrops, but this material rarely has a depth of over a few inches in areas of relief where erosion is active.

The deposits of clay in Section 2 are probably the result of hydrothermal alteration of tuff to halloysite (?) along a fault zone. The clay is white to light yellow colored and occurs as irregular bodies up to 15 or 20 feet thick over a distance of approximately 1200 feet. Claims dated 1957 cover the area of significant outcropping deposits.

Construction Materials

Twp. 27N., Rge. 32E.

Sandy-Clay Binder or Impervious Fill - Section 33

Lake Lahontan lagoonal deposits of sandy clay crop out in the S½ of Section 33. The clayish beds are relatively impure throughout and grade laterally into sandy gravel. The deposit measures approximately 250 feet wide by 1200 feet long, and may have an average depth of 10 feet (although maximum depths of 12 feet were observed). Its volume is calculated at approximately 110,000 cubic yards.

The material would probably be suitable for binder or impervious fill for dams or other construction uses, but it is too impure for use in the ceramic industry. Any significant value of such material is dependent upon local demand. Similar deposits are known farther south on both the east and west sides of the Humboldt Range.

Gravel Deposits

Sections 17 and 18. The Lahontan lake bar deposits in this area have produced considerable gravel and sand for construction purposes. Lenses of sand and fine gravel (of variable composition, but mostly sedimentary rock fragments) are interbedded with coarser gravelly material. Observed thickness is as much as 12 feet, but locally the maximum thickness could be considerably greater.

Section 21. Beach and bar deposits of rounded gravel and minor amounts of sand derived from the adjacent highlands are quite extensive in Section 21. Thicknesses as great as 30 feet were noted, but an average thickness would be much less. There has been no production from this area, but there has been some small scale prospecting with a bulldozer.

Water

Twp. 27N., Rge. 32E.

In the alluviated western part of the township, water is fairly abundant, although the quality generally leaves something to be desired. Local water supplies in the mountain area are limited to meager springs. One spring, near the common boundary between Sections 35 and 36, was sampled and the water was analyzed by J.G. Maurer of the Southern Pacific Laboratory. Maurer (1957) reported the following results:

Spring Water Sample R-36-27-32-1 Ch (Wa) June(1957)

	PPM	Percent
Chlorine as Cl	202.0	18.7
Sulfate as SO_4	430.0	39.7
Bicarbonate as HCO_3	116.0	10.7
Carbonate as CO_3	None	-
Sodium as Na	10.9	10.0
Potassium as K	None	-
Calcium as Ca	127.0	11.7
Magnesium as Mg	88.0	8.1
Zinc as An	None	
Copper as Cu	None	
Silver as Ag	None	
Arsenic as AsO_4	None	
Antimony as Sb	None	
Unassigned (largely silica)	11.9	1.1
Salinity calc as NaCl	333	
Total dissolved solids	985.8	

pH of 7.6

Arsenic, copper and potassium were sought by sensitive chemical technique along with the major constituents. Determinations of the other trace elements (zinc, silver and antimony) were made by emission spectograph.

Results indicate that the spring flows a potable sulfate water of moderate mineral content for this region.

Other Development Possibilities

Twp. 27N., Rge. 32E.

Agricultural Development

Section 5. The main highway (U.S. 40 - U.S. 95) traverses Section 5 approximately 5 miles from Lovelock and, therefore, the lands immediately adjacent to the highway are conveniently located for billboard advertisement purposes for Lovelock businesses.

Industrial Sites

Section 5. Possible industrial site. Both the Southern Pacific railroad and the main highway (U.S. 40 - U.S. 95) traverse the section. The land is almost level and water and power are conveniently available.

Section 9. Possible industrial site. Transportation facilities are approximately one mile from the property. Most of the lands comprising Section 9 have a slight down slope to the northwest. Water and power are available.

Section 17. This former Southern Pacific-owned section was purchased by the U.S. Gypsum Company for a gypsum milling plant site. Original development plans were shelved when U.S. Gypsum purchased the Empire plant at Gerlach, Nevada.

The Lovelock gypsum deposits are still undeveloped, and at such time as they are utilized a plant must be constructed. Sections 19, 29, and possibly 31 are Southern Pacific Company-owned lands that are in similarly favorable locations for a mill site.

Section 19. Possible industrial site that is 2 miles from Lovelock and 1/2 mile from present rail and highway facilities. Water and power are available.

Section 29. Possible gypsum mill site that is approximately 3 miles from Lovelock and rail and highway facilities. Water and power are available. The eastern part of the section has a gentle upslope to the east toward the gypsum deposits. The western edge of Section 29 and all the lands west toward Lovelock and the present transportation facilities are essentially flat and level.

The location from one mile to 1½ miles from the major gypsum deposits on a slight downgrade slope is especially attractive for consideration of low-cost belt feed to the mill site. With modern long belt feed methods now available, Section 29 may be much more suitable as a mill site than Section 17, which was originally purchased for that purpose.

Section 31. Possible industrial site, but generally is not as favorable as those sections discussed above.

Metallic Deposits

Twp. 27N., Rge. 33E.

Antimony

Sutherland Antimony Mine in Section 15. The Sutherland antimony mine is located in the central part of Section 15 in what has been referred to as the Black Knob mining district (Lincoln, 1923, p. 201-2). The property is currently idle and has been for a number of years, but there was considerable production from the mine in the early 1900s and during World War I.

The antimony occurs as stibnite blebs and masses in quartz veins. Supposedly a vein up to 4 feet thick and carrying 40% antimony was mined at depth. However, at the surface only small quartz veins 2 or 3 inches wide were observed. Country rock consists primarily of light yellow to reddish colored calcareous shaly rock of Mesozoic age. Locally, limestone and quartz sandstone is interbedded with the shaly rock. The bedding strikes approximately N 15 W and dips SW at moderate angles. The quartz veins tend to follow bedding planes in general strike, but commonly dip steeply to the northeast. Other quartz veins have a general strike N 10 E and dip steeply either east or west.

The Sutherland deposit and adjacent lands were examined by Fitzpatrick (1908) and by Coe (1909), both of whom wrote reports regarding Section 15. They describe how the property has been prospected and developed by numerous surface and subsurface workings.

Major production came from a 4-6 foot thick vein developed by the main shaft. Little ore is to be seen on the surface today, and the underground workings are largely inaccessible. A character sample from the dump gave the following assay results:

R-15-27-33-1 Ch (a)

Gold - - - - - - - -	None
Silver - - - - - - -	0.05 oz. per ton
Lead - - - - - - - -	None
Copper - - - - - - -	None
Antimony - - - - - -	10.56%

Supposedly the ore that was originally mined and shipped averaged at least 35% antimony.

The adjacent parts of Section 15 which are still in company ownership may have some prospective value for antimony, but current interest in such deposits is too low to justify exploration costs.

Prospects in NW¼ of Section 11. A small oxidized zone along a N 45 W trending fault has been prospected to the extent of several small pits. Country rock is a dark colored conglomeritic limestone. No ore minerals were identified in the oxidized gossan-like rock or in the associated calcite veins in the current survey, the associated calcite veins in the current survey, but Mack (1929, p. 2) reported that traces of both antimony and cinnabar were present. The prospects are considered to be occurrences that do not warrant additional work.

Cinnabar

Paymaster Prospect in Sections 11, 13 and 14. The Paymaster prospect is located on limestone in the NE¼ of Section 14. Comparable limestone extends both northwestward into Section 11 and southeastward into Section 13, and throughout the length of the limestone outcrop one may occasionally find disseminated crystals or blebs of cinnabar.

The original discovery was made in 1929 (Bailey and Phoenix, 1944, p. 169) and subsequently an inclined shaft was driven and numerous pits and trenches were dug along the mineralized shear zone. Small bodies of cinnabar are present, but no workable ore bodies have been found. The production record is nil.

The cinnabar occurs in both crystalline and cryptocrystalline form as disseminated replacement bodies in the limestone and in small fracture filling veins of calcite, dolomite and ankerite. The limestone host rock is dark colored and mostly massive, but in parts it is conglomeritic. No significant mineralization was noted in the associated shaly beds.

Examinations of Section 11 and the Paymaster area were made by Mack (1929 and 1941), Simons (1950) and by Cohen in the current survey. The concensus is that the area shows meager cinnabar mineralization that attracts attention from time to time, but there is little likelihood of developing significant deposits.

Miscellaneous Unnamed Prospects

Adit in E½ of Section 5. A 30 foot long adit prospects a 6 foot thick north-trending acidic dike that dips 75°E. The small associated quartz veins do not show any visible metallic mineralization, and the fact that the work has long been abandoned indicates there is little or no ore value.

Prospect in E½ of Section 6. The contact between metasedimentary rock and an overlying rhyolite flow has been trenched with a bulldozer. A 3 foot thick zone at the base of the light colored rhyolite is criss-crossed with ferruginous appearing "veins" up to 1½ inches wide. No ore minerals were identified. The zone seems to be the result of flow contact phenomena and has no economic significance.

Nonmetallic Deposits

Twp. 27N., Rge. 33E.

Clay

Bentonitic clay deposits in Sections 7, 8 and 9. Low grade clay deposits are associated with the volcanic rocks of Tertiary age that crop out in this part of the township. The clay has been considered as bentonite, although the swelling characteristics are very poor. All of the known deposits are quite gritty and must be classified as impure. Even the best material, from the west-central part of Section 8, is fairly impure.

The white to light brown colored clay has been derived mostly from alteration of tuffaceous beds, but some seems to be the result of alteration of acidic flow rocks. Maximum observed thickness of clay zones was 6 feet, and the average thickness is considerably less.

A previous report on Section 7 (Simons, 1951) contains a discussion of the deposits in Sections 7 and 8 and their potential. The area was prospected by the American Colloid Company of Chicago in 1949 with the hope of developing significant clay deposits for future use. However, in general, their work failed to show there was sufficient quantity or suitable quality of clay to be of interest in the present market.

Extensive drilling, stripping and sampling would be necessary to make a reasonably reliable determination of the limits and depth of these low grade deposits. Because the occurrences of clay on Southern Pacific Company-owned Sections 7 and 9 seem small in comparison with those in Section 8 (where prospecting has failed to develop commercial deposits), it is considered that the occurrences on company land have no current economic value and little potential value and, therefore, do not warrant additional work at this time.

Perlite

Prospects in SE¼ of Section 16. Small, irregularly shaped perlitic masses are associated with Tertiary acidic flow rocks cropping out in the SE¼ of Section 16 are covered by claims staked July 23, 1956. The fine-grained flow rocks and the glossy perlitic rocks all show prominent flow structures. The perlite bodies locally attain a thickness of 15 feet, but average much less. Although some of the perlite is a typical blue-gray color and has a good perlitic texture, it failed to expand readily when tested with a small gas torch.

Small scale prospecting with a bulldozer has failed to develop an economic deposit, and judging from the regional characteristics of the acidic flow rocks it is unlikely that more encouraging prospects will be developed in this area.

Water

Twp. 27N., Rge. 33E.

Water supplies are limited in this township. A U.S. Grazing Service well and windmill in the SW¼ of Section 8 has supplied water for cattle in past seasons, but there was no water being pumped at the site in 1957.

No information about the well was secured in 1957, but depth data, etc. could possibly be obtained from the Nevada State Engineer's office.

Small quantities of water are available from a well in Section 24. Springs are present at various places in the adjacent townships but none are known in the area of Twp. 27N., Rge. 33E.

Water Sample R-24-27-32-1 Cd (Wa) SW¼ of Section 24

The former U.S. Grazing Service well in Section 24 is very close to the mutual boundary between Sections 24 and Southern Pacific Section 25. When originally drilled, the well supposedly produced at a 5 gpm rate, but current production is between 1 and 3 gpm. A one gallon sample was taken in May, 1957 and submitted to the Southern Pacific Laboratory for analysis. Maurer (1957a) reported the following results:

Well Water Sample R-24-27-33-1 Cd (Wa) (May, 1957)

	PPM	Percent
Chlorine as Cl	268.0	40.2
Sulfate as SO_4	49.0	7.4
Bicarbonate as HCO_3	88.0	13.2
Carbonate as CO_3	None	-
Sodium as Na	74.0	11.1
Potassium as K	4.0	0.6
Calcium as Ca	114.0	17.1
Magnesium as Mg	30.0	4.5
Zinc as Zn	None	-
Copper as Cu	None	-
Silver as Ag	None	-
Arsenic as AsO_4	None	-
Antimony as Sb	None	-
Unassigned (largely silica)	39.3 calc	5.9
Salinity calc as NaCl	443	
Total dissolved solics	666.3	

pH of 7.7

The arsenic, copper and potassium were sought by sensitive chemical techniques along with the major constituents. Determinations of the other trace elements (zinc, silver and antimony) were made by emission spectograph.

Results show that the ground water in the vicinity of East Coal Canyon and Packard Wash has a high chlorine content and a silica content that is relatively higher than known from other water supplies in the region. It is thought that dissolved solids in this water indicate a pronounced influence on the water by rocks of the Tertiary volcanic terrane adjacent to the west. The water is considered suitable for stock use and not too intolerable for domestic use. Similar water supplies could probably be developed on adjacent Southern Pacific Company Section 25.

GEOLOGIC SETTING

Metamorphosed sedimentary rocks of early Mesozoic age, intrusive rocks of Jurassic and Tertiary ages, and a sequence of Tertiary flow rocks and tuffs with minor associated sedimentary beds comprise the major bedrock units. Various types of sediments deposited in or by the waters of Pleistocene Lake Lahontan and several younger surficial deposits have also been differentiated.

The region has been intensively prospected, but to date the only significant mineral production (during World War I) has been antimony from the Sutherland Mine in Sec. 15, Twp. 27N., Rge. 33E. The Lovelock gypsum deposits in the vicinity of Sec. 27, Twp. 27N., Rge. 32E. are large, low-grade deposits that are promising for future mineral commodity production.

Rich agricultural land developed in the vicinity of Lovelock along the Humboldt River has yielded abundant alfalfa crops for many years and will probably continue to do so as long as present water supplies are maintained.

Triassic and Jurassic Metasedimentary Rocks

Metasedimentary rocks of Mesozoic age comprise the bulk of the bedrock exposed in the part of the Humboldt Range shown on the accompanying maps and discussed in this report. Because the Lovelock gypsum deposits were thought to be directly associated with these rocks, an attempt was made to establish a geologic sequence and to differentiate various members of the sequence where deemed feasible and appropriate because of possible gypsum deposits. As a result, in some areas various types of metasedimentary rocks were distinguished, but much of the area was subsequently mapped as undifferentiated metasedimentary rocks. Throughout the range, limestone beds were mapped wherever they were found.

Establishing a valid geologic sequence on the basis of reconnaissance mapping in this area is extremely difficult because of intricate folding and probable thrust faulting of the various rocks. Cohen (1957) mapped and described Pershing (?) group rocks as "Older Gypsum Sequence" and a "Younger Gypsum Sequence", the two gypsum sequences being separated by a major structural unconformity. The description of the sequences and their component "members" follow in order from oldest to youngest. Following the discussion of both gypsum sequences is a statement presenting an alternative interpretation of the gypsiferous and associated rocks.

Pershing (?) Group Undifferentiated

Distribution. Rocks thought to be possibly correlative with the Pershing group (Danehy, 1957) seem to "cap" some of the higher parts of the Humboldt Range directly east of Lovelock. This position of the oldest mapped rocks is anomalous, but can possibly be explained by major thrust faulting.

Lithology and thickness. The major part of the Pershing (?) group in this area is a sequence of brown weathering greenish shale or argillite with pronounced pencil fracture developed in many places. Locally the rocks are siliceous or calcareous and there are a few interbeds of dark gray limestone up to 3 feet thick. Thin quartzose sandstone beds with irregular fracture are not abundant, but where seen they contrast markedly with the "pencil shale".

Thickness was not measured, but a minimum thickness of 1000 feet is estimated with neither the top nor the bottom of the sequence definitely recognized in this mapped area.

Relationship to other rocks. These rocks seemingly overlie younger darker colored shaly rocks. Of course, this apparent "capping" relationship to younger rocks is anomalous.

Overturning of beds and thrust faulting of similar rocks are known in adjacent parts of the region and there are a few field indications of comparable or more extensive deformation in this area. Some of the structural observations suggest that the contact is actually an overturned angular unconformity, but much more detailed geologic mapping would be necessary to provide reliable factual proof.

Volcanic rocks of Tertiary age unconformably overlie the Pershing (?) rocks locally in this and adjacent areas.

Age. Monotis fossils of Upper Triassic age are found at several localities in this area (S½ of Sec. 35, Twp. 27N., Rge. 32E., NE¼ of Sec. 27, Twp. 27N., Rge. 32E., and S½ of Sec. 14, Twp. 27N., Rge. 32E.). On the basis of these fossils, the entire Pershing (?) group sequence is tentatively considered to be of Upper Triassic age.

Economics. The Pershing (?) group rocks in the area covered by this report do not have any known economic value, although in the adjacent Antelope Springs district (Danehy, 1957b) states some of the Pershing group rocks are host to mercury mineralization.

"Older Gypsum Sequence"

This sequence contains the major part of the gypsum in the Lovelock deposits. It is comprised of several different distinctive rock types which are described below.

Distribution. Rocks of this sequence crop out on the western flank of the Humboldt Range in a belt extending through Sections 15, 22 and 27 of Twp. 27N., Rge. 32E. Comparable rocks may be exposed elsewhere, but were not differentiated in the present survey.

Lithology. The following "members or units" comprise the "older gypsum sequence" (in apparent order from oldest to youngest).

TRols 1 - Dark gray to black, thin-bedded limestone at least 6 feet thick. Locally has well developed fracture cleavage, but generally has less white calcite veins than limestone beds higher in the sequence. Occurs at southern border of main deposit.

TRopsh 1- Purplish reddish shale and slaty rocks from major part of the unit, but light colored sandy siltstone, dark blue-gray calcareous shale, white limestone and gypsum are interbedded with the purplish rocks.

TRog 1 - Gypsum occurs as irregular shaped masses locally associated with white limestone interbedded with the purple shale unit (TRopsh 1). Gypsum is soft and earthy to granular (efflorescent) at the surface.

TRols 2 - Blue-gray limestone with a locally overlying zone of white limestone. The dark limestone has average thickness of about 10 ft; the white limestone, where present, is much thinner. The dark limestone is cut by abundant small white calcite veins.

TRopsh 2- Reddish-purple shale and slate at least 50 ft. thick, lithologically indistiguishable from the previously described purple shale unit (TRopsh 1).

TRog 2 - Gypsum comprising the main mass of the Lovelock deposit. At the surface the gypsum is the relatively pure, loose, spongy efflorescent variety derived from the underlying impure rock gypsum beds. At depths of 70 feet to 140 feet, the gypsum grades into anhydrite (indicating that the entire deposit was probably anhydrite at one time).

TRols 3 - Blue-black limestone up to 25 feet thick locally overlies massive white limestone with a maximum thickness of 25 feet, but generally directly overlies the main gypsum beds (TRog 2). Thin, white calcite veins are scattered throughout the dark limestone.

TRopsh 3- Purple-reddish shale and slate 100 feet thick and similar to those already described (TRopsh 1 and TRopsh 2) overlies the dark limestone (TRols 3).

Age and relationship of "Older Gypsum Sequence" to other rocks. These rocks have not yielded fossil evidence of age, nor are they strictly lithologically similar to dated rocks in the region. They are somewhat similar to rocks of Triassic or Jurassic age (except for the gypsum) so the rocks of the "Older Gypsum Sequence" have been tenatively assigned a questionable Triassic age.

Major structural breaks are thought to separate the rocks of the "Older Gypsum Sequence" from adjacent rocks of Mesozoic age. Drill information (Havard, 1957) suggests that the "base" of the main gypsum deposit is a thrust fault. A major structural unconformity is postulated by Cohen (1957) as a line of separation between the "older" and the "younger" gypsum deposits. Good criteria of relationships are lacking and a great deal more detailed work would be required to establish positive relationships.

Economics. The economic possibilities of the Lovelock gypsum deposits have been discussed under the heading of Nonmetallic Deposits, Twp. 27N., Rge. 32E.

Younger Gypsum Sequence

The younger gypsum sequence includes a minor gypsum occurrence in the vicinity of the major deposits and the isolated occurrences in Sections 34 and 35 (Twp. 27N., Rge. 32E.). Cohen (1957) has considered the sequence as "younger" because he thought a relatively unbroken sequence could be established between rocks of the "Younger Gypsum Sequence" and the apparently overlying greenish "pencil shale cap rock". Although the sequence established by Cohen may be valid, there is some doubt cast on the age relationships by the identification of Upper Triassic Monotis fossils in the capping rocks (mapped as Pershing (?) Group) and tentative identification (Wallace, 1957) of a Jurassic fauna from some of the apparently underlying beds (mapped as undifferentiated metasedimentary rocks - JTRu).

The units or members of the "younger" sequence are described below largely as Cohen (1957) reported them, but the age symbol on the map has been changed from Triassic to Jurassic to agree with current information and to provide more readily distinguished map units.

Distribution. Limestone and purple shaly rocks of the "younger" sequence have been mapped along the secondary western crest of the Humboldt Range in Twp. 27N., Rge. 32E. and along the main crest of the range in Twp. 27N., Rge. 33E. Gypsum occurrences are confined to Sections 27, 34 and 35, with a very minor occurrence near the common section line between Sections 11 and 14.

Lithology. The following "members or units" comprise the "younger gypsum sequence" (in apparent order from oldest to youngest):

Gypsh - Purplish-reddish shale and slate up to 50 feet thick. Locally contains interbedded gypsiferous, sandy shale that grades into white gypsite (Jyg). The character of both the shale rocks and the gypsum is very similar to rocks described in the "older gypsum sequence".

Jyg - Gypsum or gypsite that grades into gypsiferous sandy shale in the purple shale part of the sequence (JYpsh).

Jyls - White limestone with some associated blue-black limestone commonly occurs as two distinct beds, each as much as 20 feet thick, separated by a zone of greenish shale and slate as much as 12 feet thick (Jysh). Locally, thrust relationships exist. The limestone beds are commonly brecciated, producing numerous black to cream colored or white fragments of limestone in a white calcite matrix.

Jysh - Greenish shale and slate interbedded with the white limestone (Jyls). Has an interbed thickness as much as 12 feet, but locally is found both above and below the limestone. The brownish weathered appearance of these shaly rocks contrasts markedly with the outcrop colors of the purple shale part of the sequence.

Age and relationship to other rocks. Cohen (1957) considered the lower part of this sequence to be terminated by a major structural unconformity. If the areal distribution of the younger purple shale (Jypsh) is as widespread as indicated on the map (there probably being comparable rocks in the areas mapped as metasedimentary rocks, undifferentiated), the relationship in an eastward direction becomes anything but obvious. Along the western margin of "Younger Gypsum Sequence" outcrop (in Sections 22 and 27, Twp. 27N., Rge. 32E.) a fault relationship is present, but elsewhere reliable relative position crieteria were not observed. Locally volcanic rocks of Tertiary age unconformably overlie rocks of the "Younger Gypsum Sequence".

As indicated in the introduction to the "Younger Gypsum Sequence", there is some doubt as to age and relationship of the younger sequence to the *Monotis* bearing Pershing (?) group of rocks of Upper Triassic age. The Jurassic (?) age is a tentative assignment on the basis of only the most meager factual evidence.

Economics. The economic possibilities of the Lovelock gypsum deposits have been discussed under the heading of Nonmetallic Deposits, Twp. 27N., Rge. 32E.

Alternative Interpretation

Although there are some apparent differences in lithology between the gypsum sequences as described, there are really more over-all similarities than dissimilarities. It seems likely that similar rocks in close geographic proximity are probably associated in time as well. Therefore, there is the distinct possibility that the various gypsum occurrences are actually part of one bed (or part of a closely associated series of gypsum beds) and that, likewise, the "purple shales" and other rocks are correlative. Complex structural relationships and slight facies changes could probably account for apparent differences in sequence and association. Detail geologic mapping, coupled with subsurface information, would be required to unravel the complex geologic relationships of the gypsum area.

Metasedimentary Rocks, Undifferentiated

The major portion of the metasedimentary terrane has been mapped as undifferentiated except for limestone beds. At Lone Mountain,(Sections 19 and 20, Twp. 27N., Rge. 31E.) an area of hornfels developed from metasedimentary rocks has been differentiated.

Lithology. The undifferentiated metasedimentary rocks in Twp. 27N., Rge. 32E. are mostly similar to the rocks of the gypsum sequences, except that no gypsum is known to outcrop or be present in any of the area mapped as undifferentiated metasedimentary rocks. In Twp. 27N., Rge. 33E. (particularly in the northeast part of the township), orangish-brownish weathering shale and slate are widespread. Locally, these rocks are cacareous, and in some places they are siliceous and include thin beds of hard, fine-grained quartzose sandstone. Much of the black limestone mapped in Section 11, Twp. 27N., Rge. 33E. is locally conglomeritic and in many ways resembles Pershing Group rocks mapped southeast of the area (Danehy, 1957b).

Age and relationship to other rocks. A probable Triassic-Jurassic age span has been assigned. The base of the sequence is not recognized and definitely dated older rocks are not known in the immediate area. Volcanic rocks of Tertiary age unconformably locally overlie the undifferentiated metasedimentary rocks.

Economics. Siliceous rocks of this group are host to antimony mineralization at the Sutherland mine (Sec. 15, Twp. 27N., Rge. 33E.). Cinnabar occurrences (noneconomic) are known in the limestone beds mapped in the vicinity of Sec. 11, Twp. 27N., Rge. 33E. There are also a few occurrences of meager gold, silver, and base metal mineralization, but nothing of economic significance is known in the entire area.

Tertiary Rocks

Truckee (?) Formation

Introduction. In this area a sequence of acidic flow rocks and tuffs with only minor sedimentary interbeds has been tentatively correlated with similar rocks in the Trinity Range to the west where "Truckee Formation" sedimentary beds are more widely distributed. The entire sequence of acidic flows and associated rocks of this area has been grouped under the name Truckee (?) formation.

For the purposes of mapping, a three fold division of the rocks was found satisfactory. Much of the area was mapped merely as tuff and flow rocks, undifferentiated. In parts of the area flow rocks and sedimentary rocks were differentiated.

Distribution. Rhyolitic flow rocks (Ttre) form bold outcrops in the N½ of Twp. 27N., Rges. 32 and 33E. The sedimentary beds (Tts) are present in relatively the same area, but there are additional occurrences beyond the western front of the Humboldt Range in the southwest quarter of Twp. 27N., Rge. 32E. Undifferentiated tuff and flow rocks (Ttv), which are mostly tuffs, are particularly prevalent along the eastern flank of the Humboldt Range in Twp. 27N., Rge. 33E.

Lithology. The rocks of the Truckee (?) formation are described below after the way they were divided and grouped for mapping purposes.

Tuff and Flow rocks, undifferentiated (Ttv) - The rocks in this category are mostly tuffaceous rocks, although there may be minor amounts of acidic to basic flow rocks and limy shale included in the group as mapped. The tuffs are predominantly white to light gray, but a few interbeds are a reddish brown color. (Locally, the tuffs are a brick red color for a depth of several feet along the contact where baked by the heat from overlying basalt flows.) Grain size varies from fine to coarse and averages in the medium coarse range.

Some pumaceous beds are present, but nothing of the purity and volume necessary for commercial production. The tuffs are locally altered to low grade bentonitic or haloysitic clay, but again the deposits lack grade and volume for economic purposes.

Rhyolite flows (Ttr) - These rocks are mostly flows, but minor tuff interbeds may be included in some of the areas as mapped. Outcrops are bold and massive, although locally columnar structure is well developed. The acidic flow rocks are brown weathering, but a creamy white color on a fresh surface. The rock is commonly porphyritic, having quartz phenocrysts in a vitric groundmass. Small zones of perlite were noted, but none of commercial possibility in the mapped area.

Sedimentary deposits (Tts) - Buff colored fresh water limestone is mapped in this category in the northern part of Rge. 33 where the limestone is near the base of the Tertiary sequence. Locally the limestone is brecciated and in some places it is conglomeratic. Calcareous rocks and fine grained water-laid tuffs are also found in small outcrop areas in Sections 28 and 33 of Twp. 27N., Rge. 32E. at the western base of the Humboldt Range.

Relationship to other rocks. Rocks of the Truckee (?) formation unconformably overlie rocks of Mesozoic age. Locally they are in turn unconformably overlain by conglomerate and basalt of late Tertiary age and by surficial deposits of Quaternary age.

Age and correlation. The rocks included in the Truckee (?) formation are thought to be of mid-Miocene to early Pliocene age, and probably correlative with the Humboldt and Esmeralda formations of other Nevada localities (Larson, 1954).

Economics. Elsewhere there are commercial deposits of various non-metallic substances directly associated with rocks of the Truckee (?) formation. In this area none of the clay deposits or the perlite and pumicite occurrences have the grade or quantity for commercial consideration in our present economy.

Conglomerate (Older, limestone clasts) (Tcg)

In the north-centrap part of Twp. 27N., Rge. 33E., conglomerate up to a thickness of 40 feet or more locally overlies volcanic rocks of Tertiary age and underlies basalt (Tpb) of late Tertiary age. The clasts are generally well rounded and most are derived from a limestone source area. The areal distribution of the conglomerate indicates that it lies almost horizontally, although locally low dips may be measured in the field.

There is no known economic significance of the conglomerate, but it was differentiated in the field, mapped and described for correlative purposes and for possible use in deciphering the late Tertiary-Quaternary geologic history of the region.

Basalt (Tpb)

Distribution. Basalt crops out at several places along the western base of the Humboldt Range (SW¼ of Twp. 27N., Rge. 32E.) in Section 25 at the crest of the range, and at many places on the eastern flank of the range. Correlative basalt is even more widespread in other parts of the surrounding region.

Lithology and thickness. The basalt is generally a dark gray color, locally vesicular, and commonly contains visible olivine phenocrysts. Calcite locally forms amygdules. Maximum thickness in this area is probably not much greater than 100 feet.

Relationship to other rocks. The basalt unconformably overlies metasedimentary rocks of Mesozoic age, older Tertiary volcanic rocks and a Tertiary conglomerate composed largely of limestone clasts (Tcg). The basal contract is considered to be unconformable throughout the area discussed in this report. Surficial deposits of Quaternary age locally overlie the basalt with angular unconformity.

Age. A probable Upper Pliocene age has been assigned to the basalt in this and adjacent parts of the region.

Economics. The basaltic rocks of this area have no known economic potential.

Quaternary Rocks

Conglomerate (Younger, rhyolite clasts) (Qtcg)

In the NE¼ of Twp. 27N., Rge. 33E., poorly consolidated conglomerate was found overlying basalt (Tpb). The clasts are in general well rounded, but locally appear fanglomeritic. Most of the pebbles and boulders are rhyolitic in composition.

The conglomerate is necessarily younger than the basalt (Tpb), but probably pre-dates the Lake Lahontan deposits considered to be of Pleistocene age. Therefore, a late Pliocene or early Quaternary age is assigned. It is possible that the conglomerate cropping out high on the hills is correlative with the dissected older alluvium (Qoa) mapped at lower elevations in the Packard Wash area (Section 25, Twp. 27N., Rge.

33E.), but because different source terranes are involved and the outcrops are isolated there is little or no correlative evidence available.

Older Alluvium (Qoa)

Distribution and lithology. Outcrops in Sections 25 and 35, Twp. 27N., Rge. 33E. have been mapped as Qoa. These unconsolidated gravelly and sandy sediments occur as hills and ridges above the level of present alluvium.

Age and relation to other rocks. This unit is better represented in Twp. 26N., Rge. 33E. where the relationships indicate that the materials represent alluvium deposited prior to or at the time of Pleistocene Lake Lahontan.

Lake Lahontan Deposits of Pleistocene Age

Materials deposited in or by the water of ancient Lake Lahontan are widespread throughout the region below an elevation of about 4,380 feet above sea level (the approximate location of the upper level of Lake Lahontan is shown on the map). Several types of Lahontan deposits have been differentiated in the course of field mapping in 1957. For additional information on the history of the lake and its distribution, the reader should consult the classic paper by Russell (1885).

Clayey-Silty Lagoonal Deposits (Qll). Fine silt and clayey material was deposited locally in restricted lagoonal areas behind beach bars. These fine-grained sediments are potential low value deposits suitable for impervious fill material (see Section 33, Twp. 27N., Rge. 32E.).

Silty lake bottom deposits (Qlsl). Silty material with local sandy facies underlie most of the flat Humboldt-Lovelock valley floor. In the parts of the region where suitable water is available, choice agricultural soils have been developed from these silty sediments. Saline deposits may be present in some parts of the Lake Lahontan basin, but at the present time there is nothing to suggest economic deposits of salts in this part of the region.

<u>Gravelly to silty beach terrace deposits (Qlt)</u>. As Lake Lahontan receded, various shortline deposits were laid down. Beach terrace or bar deposits are well developed from an elevation of about 4,000 feet up to the highest level of the lake (about 4,380 feet). The most prominent beach lines have been symbolized on the map.

The terrace deposits have a wide range in size and composition of the clastic material. The coarser gravel bars are the most resistant to erosion and, therefore, form distinctive topographic features. Much of the area has a silt veneer over gravelly or sandy deposits.

Economically, the gravel beaches are the source of aggregate material and road metal used on the county roads and private roads throughout the area (Sections 17 and 18, Twp. 27N., Rge. 32E.).

<u>Granitic Sand with Minor Gravel</u> (Qlgr).

In the vicinity of Lone Mountain (west of Lovelock), the Lahontan bars and terrace deposits are composed of materials derived from the granite and rhyolite that crops out on Lone Mountain. The sand is distinctly granitic, but the gravel and coarser fragments are predominantly rhyolitic. In Sections 20 and 29, Twp. 27N., Rge. 31E., the granitic sand deposits have yielded considerable material for local construction purposes.

<u>Calcareous tufa (Qltfc)</u>. In the northwestern part of Twp. 27N., Rge. 31E., and in the southwestern part of Twp. 27N., Rge. 32E., calcareous tufa forms pillar-like outcrops as much as 15 feet high. In this area the tufa deposits have about a 100 foot range in elevation of occurrence (between 4,060 feet and 4,160 feet as taken from topographic map). The tufa has no current economic significance in this area.

Gravelly to Silty Fan Deposits (Qf)

Fan deposits derived from the mountainous areas and transported by intermittent streams cover large gentle slope areas above the valley floors. The composition of the clasts is governed by the source area rock types.

Size range varies from poorly sorted bouldery gravel nearest the source mountains to sandy, and even silty, materials farthest from the place of derivation. Basaltic source terrane produces an abundance of boulders which persist for a considerable distance and often make passage of vehicles difficult or impossible.

Economically, the fan deposits have some value as sources of road metal if the fans are located close enough to the area of utilization. In this area the gravelly Lahontan deposits have been more widely used than the fan materials.

Eolian Deposits (Qed)

Dune and sheet sand deposits cover a strip of land along the eastern margin of the Humboldt River and also are present along the side of the valley west of Lovelock. Most of the eolian materials are thin sheet sand deposits, but in Sections 19 and 30, Twp. 27N., Rge. 32E., dunes up to 15 feet high are well developed.

Southwesterly winds have transported the bulk of the material from the bed of the Humboldt River and from the Humboldt Lake dessication plain farther to the south. The sand is fine to very fine grained. Most of the eolian deposits are fairly well stabilized at the present time by a cover of various grasses and desert brush.

Economically, the eolian deposits are mostly of negative interest. Where the land is flat and the sand cover relatively thin and uniform, it has been possible to develop the land for agricultural purposes. Limited water supply and drainage are the development control factors at the present time.

Secondary Gypsum (Qalg in Section 33, Twp. 27N., Rge. 32E.)

A small area of gypsum is shown on the map in the NE¼ of Section 33, Twp. 27N., Rge. 32E. This occurrence is redeposited on secondary deposit of gypsiferous material derived from the main Lovelock gypsum deposits cropping out northeast of this area. Part of the deposit is efflorescent gypsum and relatively pure, but most of it contains considerable detrital shale and limestone and, therefore, is a gypsiferous conglomerate. The deposit has limited economic possibility as discussed under mineral resources.

Sandy and Silty Alluvium and Colluvial Deposits

Alluvium along the Humboldt River is mostly silt to fine grained sand. In the eastern part of the area along Packard Wash, the size range is from silt and silty clay to boulders in those areas where fan deposits have not been differentiated. Colluvial deposits are confined to such areas as East Coal Canyon and the gentle slopes of landsin and adjacent to Section 12, Twp. 27N., Rge. 33E.

The thickness of the alluvial materials is slight in most areas; an unknown, but considerable, thickness is present along Packard Wash.

The well in the SW¼ of Section 24, Twp. 27N., Rge. 33E. is reported to be in alluvial material for its full depth of several hundred feet.

Intrusive Rocks

Jurassic (?) Granite(Jgr)

Distribution. Granite crops out in the Lone Mountain area west of Lovelock, and a small outcrop is present near the crest of the Humboldt

Range in Section 25, Twp. 27N., Rge. 32E.

Lithology. The Lone Mountain granite is coarse grained and has large pink orthoclase phenocrysts. Biotite and hornblende (?) are the mafic accessory minerals.

The small outcrop in Section 25, Twp. 27N., Rge. 32E. is composed of a more equigranular granite, with little or no recognizable pink feldspar. Small aplite bodies are associated with the granite.

Fine-grained whitish gray aplite dikes are common. Joints controlled emplacement of the aplite dikes. Joints also somewhat control weathering of the granite into rounded knobs after original outlines of large joint blocks.

Age and relationship to other rocks. The granite intrudes metasedimentary rocks of Triassic-Jurassic age. It is unconformably overlain by rhyolitic volcanic rocks of mid-Tertiary age. Granite in other parts of the adjacent region was dated by Jenny (1935, p. 18) as probably Jura-Cretaceous. Lacking reliable age criteria, a probable Jurassic age has been assigned to the granitic rocks cropping out within the area described in this report.

Economics. Granitic sand derived from Lone Mountain has been used locally as construction material. Hornfels are developed in the metasedimentary rocks adjacent to the granite, but there was no evidence seen of a possible scheelite-bearing tactite zone. Checking of several placer samples from the Lone Mountain area with an ultraviolet lamp failed to give any indication of scheelite. It is considered unlikely that the granite itself would have any particular economic value in this area.

Jurassic (?) Dike Rocks, Undifferentiated (du)

Distribution. Dikes in this category were mapped in Sections 10, 12, 14 and 28, Twp. 27N., Rge. 32E., and in Section 5, Twp. 27N., Rge. 33E.

Lithology. The dikes are mostly fine grained acidic rocks that weather a buff color. Cubical pyrite, up to 1/4 inch diameter, is common, but nowhere abundant. Some of the mineralization in the Muttleberry mine area may have a genetic association with the dike rocks, but elsewhere the dike rocks did not seem to have any economic significance.

Age. The dikes cropping out in the NE¼ of Section 28, Twp. 27N., Rge. 32E. are folded with the enclosing sedimentary rocks and, therefore, similar dikes are considered to be of probable Jurassic age. In the NE¼ of Twp. 27N., Rge. 32E. there are dike rocks that are mapped as undifferentiated that may belong to the rhyolitic intrusive group described below (Tri).

Tertiary Rhyolitic Sills and Dikes (Tri)

Distribution. Main occurrence is in the vicinity of Section 6, Twp. 27N., Rge. 33E.

Lithology. The rock is a light colored aphanitic rhyolite in tabular bodies up to 25 feet thick. Thin quartz veins are common in the adjacent country rock. Upper and lower contacts are locally brecciated and in places have a thin baked zone.

Age. These rocks are considered to be intrusive equivalents of some of the acidic volcanic rocks in the Truckee (?) formation of Tertiary age.

STRUCTURAL FEATURES

Folds

Large-scale Folds

Structural relationships of the Mesozoic rocks are complex in the region discussed in this report, and in only a few places was it possible to delimit folds on the basis of reconnaissance examination.

Near the crest of the Humboldt Range in Sections 13 and 24, Twp. 27N., Rge. 32E., attitudes observed in the carbonate beds indicate a gentle anticlinal structure that may be traced for over a mile.

In the area of the gypsum deposits, an overturned syncline is mapped in the vicinity of Sections 15 and 22, Twp. 27N., Rge. 32E. The main deposits in Sections 27 and 28, Twp. 27N., Rge. 32E. seem to be anticlinal but the evidence at hand is not conclusive.

Small Scale Folds

The incompetent thin-bedded rocks (gypsum, purplish and dark gray to black shale) are locally intricately deformed. Overturned, asymetric and irregular folds are common and beyond reconnaissance mapping resolution.

Age of Folding

Various lines of evidence suggest that extensive folding in this region of Nevada took place during the latter part of Jurassic time or early in Cretaceous time. Closer dating of the folding in the immediate area is hampered by lack of Cretaceous rocks. Potassium-argon or other age determination methods will eventually be applied to the intrusive rocks, but at the present time such data is not available.

Previous workers, Louderbach (1904), Jenny (1935), Cameron (1939), Nolan (1943), and Muller and others (1951) all concur in a probable upper Jurassic age of folding.

Faults

Thrust Faults

Thrust faulting of considerable magnitude is thought to have displaced the Lovelock gypsum deposits from their original site of deposition. Similar faults may involve the other Mesozoic rocks as well. Within the map area described in this report, probable thrust faulting has been indicated in the vicinity of the gypsum deposits. The limestone in the S½ of Section 14, Twp. 27N., Rge. 32E. appears to be in thrust relationship, and Danehy (1957a) has shown similar thrusting to be present to the south. Meager direction of movement data suggest that the overthrust came from a westerly direction.

Major Basin-Range Faults

East side Humboldt Range block fault. In the area where Packard Wash narrows in the southeast corner of Twp. 27N., Rge. 33E., Tertiary basalt crops out on the west and dips to the east under the alluvium. A mile or less to the east, Triassic Pershing group rocks crop out. This relationships indicates a possible fault downdropping the western (basalt) outcrops and uplifting the eastern outcrops (Pershing group rocks).

This fault may continue to the north as either the Humboldt Queen fault or the Lincoln Hill fault mapped in Twp. 28N., Rges. 33 and 34E. or to the northeast as the Black Ridge fault at the east side of Packard Flat. The fault is inferred to continue south along the east side of the Humboldt Range in Twp. 26N., Rge. 33E.

West side Humboldt Range block faults. Major range bounding faults are shown along the western base of the Humboldt Range. There is good evidence present of the northwest trending fault in the southern part of Rge. 32E. in the form of fault surfaces and displacement of the Tertiary rocks. The northeast trending fault bounding the range from Section 29 to Section 3, Twp. 27N., Rge. 32E. is inferred on the basis of structural truncation.

Transferse Faults

Faults with a northeast trend displace and offset beds a moderate amount. Some of the more significant faults of this nature have been mapped in Sections 11 and 22, Twp. 27N., Rge. 32E.

Other Faults

Numerous normal faults are present in the Tertiary volcanic terrane in the south half of Twp. 27N., Rge. 33E. Displacement on these faults match that of the major basin-range faults; west side down, east side up, and the blocks tilted gently to the east.

Age of Faulting

A late Tertiary (post "basalt") age of faulting is suggested for most of the mapped faults. Louderbach (1904) describes the criteria in considerable detail.

FIELD WORK

During the months of April, May, June and July of 1957, 30 man field days were spent mapping the area of the three townships, Twp. 27N., Rges. 31, 32 and 33E.

Geophysics

Hand specimens were checked in the field office with both a scintillator and an ultraviolet light, but no anomalous material was noted. No geophysical traverses were made in this area during 1957.

RECOMMENDATIONS

In consideration of our present knowledge of the mineral resources of the area and the Southern Pacific Company land distribution, no further mineral resources survey work is warranted.

Some of the valley lands may warrant promotion as industrial sites.

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GEOLOGY AND MINERAL RESOURCES
OF
TOWNSHIP 28 NORTH
RANGES 31 AND 32 EAST
MOUNT DIABLO BASE AND MERIDIAN
PERSHING COUNTY, NEVADA

Geology and Preliminary Report by:

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Date: July 26, 1957

Revised Report by:

W. A. Oesterling
Geologist

Date: March 22, 1960

INTRODUCTION

The south boundary of Township 38 North, Ranges 31 and 32 East, Mount Diablo Meridian, is four miles north of Lovelock, Nevada in Pershing County. U.S. Highway 40 and the Southern Pacific railroad cross the east township from northeast to southwest.

At the Colado Junction siding in Section 33 of the east township are located iron ore stockpiles (ore from Mineral Basin) and loading ramps, and the diatomaceous earth processing plant of the Eagle Pitcher Company, which has been in operation since 1958-59.

CONCLUSIONS

Twp. 28N., Rge. 31E.

Fee Ownership - Southern Pacific Company

Sections 1*, 3(part), 5(part), 7, 9, 11*, 13*, 15, 17, 19(part), 21, 23*, 25*, 27*, 29, 31*, and 35* . . . Nonmineral.

Note: Those sections marked with an asterisk potentially contain deposits of sand and gravel, but are not deemed worthy of a "mineral" classification because other extensive sand and gravel deposits are more favorably located in this general area.

Oil-and-Gas-Rights-Only - Southern Pacific Company

Section 19(part) . . . Oil and gas potential is nil.

Twp. 28N., Rge. 32E.

Fee Ownership - Southern Pacific Company

Sections 3, 5, 7, 9, 17, 19, 25 (all but $SW\frac{1}{4}SW\frac{1}{4}$), 28 ($S\frac{1}{2}S\frac{1}{2}$ and $NE\frac{1}{4}SE\frac{1}{4}$), 29 ($S\frac{1}{2}$), 30(part), and 31 (all but $SE\frac{1}{4}$) . . . Nonmineral.

Note: All of these sections, except Section 25, potentially contain deposits of sand and gravel, but are not deemed worthy of a "mineral" classification because other similar deposits are more favorably located.

Section Evaluation

Sections 1, 11, 13, 27, 28 (part), 33, and 35 . . . Potention mineral, potential sand and gravel.

Note: These sections are favorably located with respect to both the Southern Pacific railroad and U.S. Highway 40 which is to be widened to freeway specifications in the near future; therefore, the sand and gravel deposits of the Lake Lahontan sediments, which are likely located in these sections, have a definite potential value.

Section 35 . . . Potential mineral. Potential light weight or plaster aggregate from tuff deposit about 2½ miles from Colado Junction siding.

Section 23 . . . Mineral. Sand and gravel pit in N½NW¼ has produced construction material from Lake Lahontan deposits and is very favorably located (60 feet from U.S. Highway 40 and 1,700 feet from the Southern Pacific railroad.

TOPOGRAPHY AND ACCESSIBILITY

The topography, road system, trails, and accessibility are shown on the geologic map, No. R 3132-28, which covers this area. The regional setting may be ascertained by inspection of the Lovelock, Nevada quadrangle topographic sheet published in 1931 by the U.S. Geological Survey.

The Humboldt River valley composes most of the eastern township as well as the southeast one-half of the western township. Humboldt River flows from north to south across the eastern township. A part of the Trinity Range is located in the northwest one-half of the western township, and a small part of the Humboldt Range composes about six square miles in the southeast corner of the eastern township.

MINERAL RESOURCES-EXAMINED

Twp. 28N., Rge. 31E.

Metallic Deposits

<u>Gold and Silver</u>

Gold and silver ore has been mined from several places within the granodiorite in Sections 3, 4, 5, and 6. All of the old adits, shafts, and inclines are driven on quartz veins. A few aplitic dikes were noted but only one of these has been prospected.

All workings are badly caved, but dumps indicate drifts up to 100 feet long. Apparently a significant amount of stoping was done in some of the mines. Much development work was concentrated in the NW¼ of Section 3, where several parallel quartz veins crop out on both sides of South Trinity Canyon. Sulphide minerals were observed at a number of small stockpiles, each less than 1 or 2 tons. Five grab samples were taken (R-03-28-31-22aPr through R-03-28-31-26aPr, APPENDIX "C"). These samples assayed from 0.1 to 128.1 ounces of silver per ton, 0.02 to 0.66 percent copper, and from a trace to 0.31 ounces of gold per ton (Union Assay Office, Inc., 1957z). None of these samples were from Southern Pacific Company land, but because of the indication of high-grade silver ore, further sampling was done in the mine workings. (Samples Nos. R-03-28-31-Pr 41 (a) through R-03-28-31-pr 54 (a). All of these 14 samples were selected channel cuts, each representing either wall rock, gouge, or quartz vein material. According to Union Assay Office, Inc. (1957b), they assayed from 0.2 to 28.3 ounces of silver per ton and from 0.0.66 ounces of gold. One sample (R-03-28-31-Pr 43 (a) assayed 1.21 percent arsenic. These samples were also assayed for tungsten (WO_3) and manganese (Mn) but the results were not encouraging. See APPENDIX "A".

Numerous pits and small inclines were noted in the slates and phyllites which crop out in the northwestern one-third of the township.

All of these prospects were very small and apparently were abandoned soon after discovery. They all follow thin quartz veins or silicified zones in the Triassic-Jurassic(?) strata. The veins which were observed all strike northeast and dip steeply to the southwest.

Nonmetallic Deposits

Perlite

Near the center of the NW$\frac{1}{4}$ of Section 19, there is a large perlite deposit of commercial grade which has been sold by the Southern Pacific Company to the U.S. Gypsum Company. This deposit is located at the southeast end of a "perlite province" which extends for at least 25 miles to the northwest, and which includes individual deposits estimated at more than 1 million tons of perlite. One of the largest of these deposits is located on Southern Pacific Company's Section 11 of T. 31N., R. 30E., 20 airline miles north of the deposit in Section 19.

U.S. Gypsum Company has extensively mined their deposit on Section 19 by bench-quarrying methods. The ore is trucked to a grinding and screening plant about two miles north of Lovelock on the Southern Pacific line. The product from this mill is then shipped by rail to Pioche, Nevada where U.S. Gypsum operates an expansion plant. According to Wisti (1958, oral communication) the perlite from Section 19 expands at a temperature of 1400-1500° F, and the expanded product weighs between 6$\frac{1}{2}$-10 pounds per cubic foot. The expansion ratio, according to Wisti, is 10 to 1. He stated that the grinding and screening mill at Lovelock has a capacity of about 1,000 tons per month if operated on a basis of one shift per day and 40 hours per week.

Perlite also occurs in the center of the S$\frac{1}{2}$NW$\frac{1}{4}$ and center of S$\frac{1}{2}$ of Section 16. The deposit is readily accessible, but is not comparable in size to the deposit in Section 19. Nothing is known of the quality of the perlite in Section 16, although much of it appears similar to that in Section 19. The deposit in Section 16 was staked for the Southern Pacific Company in 1957, but these claims are not now considered to be of value because much larger deposits were later located on Southern Pacific Company land.

All of the perlite deposits are closely associated with rhyolitic lavas. Those in the area of this report were correlated with the "Truckee" (?) formation volcanics, while in the adjacent township to the west Bonham and Schafer (1958) mapped perlite bodies within their "Toll Rock formation". The perlite in Section 19 is at least 90 feet thick and appears to be completely surrounded by rhyolite. In Section 16, the perlite locally can be observed to grade into rhyolite.

The perlite is typically bluish gray, massive, and well jointed, commonly with columnar joints which are coated a dark reddish brown. The texture varies from perlitic (spheres with onion-skin parting) to tapered prismatic. The lustre is dull to glassy.

The following information was abstracted from "Mineral Information Service", Vol. 1, No. 4, April, 1948, published by the State of California, Division of Mines:

> Perlite is a variety of obsidian (volcanic glass) derived from granitic magma during volcanic eruption. Perlite is composed of 65% to 75% silica 9% to 20% alumina; less than 8% sodium and potassium oxides; less than 3% calcium and magnesium oxides; less than 3% iron oxide; and about 3% water.
>
> According to Chesterman (1948):
>
> "Chemical analyses of some perlites show that they differ from other volcanic glasses such as obsidian, tachylite, vitrophyre, and pitchstone by containing two to four per-cent water.".

Construction Materials

Sand and Gravel

Small pits with 15- to 20-foot faces expose sand and gravel of apparently good quality in Lake Lahontan gravel bars in the SW$\frac{1}{4}$SW$\frac{1}{4}$ of Section 27 and in the NE$\frac{1}{4}$ of Section 31. The gravels are composed essentially of metamorphic slates and phyllites with some quartzite clasts and finer detritus (to sand and silt size) of granodiorite material.

Although no other sand and gravel deposits were observed, much sand and gravel is probably contained in the southeast one-half of the township which is underlain by Lake Lahontan deposits. In addition to Sections 27 and 31, mentioned above, Southern Pacific Company Sections 1, 13, 23, 25, and 35 potentially contain sand and gravel deposits. However, other deposits of these materials are much more favorably located with respect to existing lines of transportation. Development of sand and gravel deposits within this township is dependent upon local demand for these materials.

Water Resources

Surface Water

Analysis of a sample of the water from a spring in Section 3, at the contact between the granodiorite and the Mesozoic strata, is within the mandatory limits for drinking water established in 1946 by the United States Public Health Service (Kiersch, 1959, p. E-51), but is not within the recommended (non-mandatory) limits. The sample was analyzed by the Southern Pacific Laboratory (Maurer, 1957 - APPENDIX "B" of this report). Results show the water to be extremely "hard" with 1244 parts per million of total dissolved solids. The recommended limit of hardness is 500 ppm "desirable" and 1,000 ppm "permitted". Also the water exceeds the recommended 250 ppm of chloride and sulphate, containing 271 ppm and 374 ppm respectively of these anions. It is concluded that this water should not be used for extended periods as drinking water, but that it is suitable for irrigation purposes and stock.

Ground Water

No new information regarding ground water is available at this time, but it appears that ground water should occur at shallow depths (20-50 feet) in the lower portions of the valley fill materials in the southeast part of the township. There is a possibility that porous sand and gravel deposits of Lake Lahontan, may exist below the water table, and these would be excellent aquifers. The thick and extensive alluvial fan deposits beyond the mouth of South Trinity Canyon may contain porous layers at some depth, and these may also be aquifers.

Twp. 28N., Rge. 32E.

Metallic Deposits

Gold, Silver and Copper Prospects

Prospects for gold, silver and copper are numerous in Sections 25, 26, and 36. One shaft, approximately 100 feet deep was sunk (Willard Mine) in 1915-18 as a promotional venture. Since then, only sporadic prospecting has been continued by various individuals. Oxidized copper minerals are visible, mostly malachite, especially in the SW$\frac{1}{4}$SW$\frac{1}{4}$ of Section 25.

Four selected grab samples from Southern Pacific land assayed less than 0.1 ounce of silver per ton, and no gold or copper (Union Assay Office, Inc., 1957c).

Three of these samples (R-25-28-32-1a through 3aPr, APPENDIX "D") were from the southcentral part of Section 25, and the fourth sample (R-35-28-32-5aPr, APPENDIX "D") was from the center of the E$\frac{1}{2}$ of Section 35.

All prospects apparently follow northeast and northwest veinlets of quartz or silicified zones which are generally within the Triassic-Jurassic (?) metamorphic beds, but are locally within the Tertiary volcanics at or near the contact with the metamorphics.

Nonmetallic Deposits

No nonmetallic deposits of apparent commercial value were observed on this township.

Construction Materials

Tuff

The white rhyolite tuff deposits in Sections 26 and 35 may have a potential value as light weight or plaster aggregate. These deposits are favorably located, being 2 to 2½ miles east of Colado Junction. The tuff is interbedded with rhyolitic to andesitic lavas.

Sandand Gravel

Deposits of sand and gravel are commonly found within the Lake Lahontan beds. One such deposit has been exploited in the N½NW¼ of Section 23, about 600 feet east of U.S. Highway 40 and 1,700 feet east of the Southern Pacific railroad. Because it is so favorably located, this deposit has a definite commercial value. Ohher such deposits likely occur within the Lake Lahontan beds along the railroad and highway. Southern Pacific Company lands along these transportation lines, which may contain additional sand and gravel beds, are Sections 1, 11, 13, 23, 27, 28, 33, and 35.

Water Resources

Surface Water

Humboldt River flows from northeast to southwest across this township. Its meandering course touches ypon Sections 1, 3, and 17 of the Southern Pacific Company, and crosses Section 29, the S½ of which is owned by the Southern Pacific Company. However, the water rights have been appropriated by the State of Nevada. No other surface waters were observed in this township.

Ground Water

There is no new information regarding the ground water conditions in this township, but the water table is, of course, within a few feet of the surface along the Humboldt River. Abundant supplies of ground water, however, would be dependent upon porous gravel beds at depth in the valley-fill materials. Such beds are known to occur within the Lake Lahontan deposits.

Christen (1920_a), reported water so hot at a depth of 30 feet in a shaft in the NE¼SE¼ of Section 27 that the shaft had to be abandoned.

Hot water is reported in a well at Eagle-Picher Company's diatomite mill in Section 32.

MINERAL RESOURCES-COMPILED

Metallic Deposits

Gold and Silver

There has been some production of gold and silver from mines in the NW¼ of Section 3 of the west township. Although no production records are available, it is believed from assays obtained that the silver values exceeded the gold values. No work was being done at the time this area was visited in 1957. Little, if any, production came from the Willard Mine area in the southeast corner of the east township. Stock was sold to the public for this venture, which appears to have been largely a promotional scheme.

Nonmetallic Deposits

Perlite

Much perlite has been mined by U.S. Gypsum Company from the perlite deposit in the NW¼ of Section 19 of the west township. No production records are available, but several hundred thousand tons have been mined by bench quarrying methods. This work is done in the summer months by a contract miner, John Pedro, of Lovelock. A sufficiently large stockpile is maintained at the mill to insure operation of the mill throughout the winter months, (Wisti, oral communication). No other production of perlite or other nonmetallic commodity has been made from either township.

Construction Materials

Sand and Gravel

According to Ottini (1941) 71,345 tons of sand and gravel have been removed by the State of Nevada Department of Highways from the gravel pit in the NW$\frac{1}{4}$NW$\frac{1}{4}$ of Section 23 of the east township. An estimated 100 tons each have been used locally from the small gravel pits in Sections 27 and 31 of the west township.

Water Resources

For a discussion of irrigation and well waters used in this area, see report by Christen (1920b).

PREVIOUS INVESTIGATIONS

The initial geological investigation in this area was by the geologists of the 40th Parallel Survey, under the direction of King in 1878. The report by King, et al., is not available to the writer. A few years later, much more work in this area was done by Louderback (1904), who described the geology of the Humboldt Range in some detail, and the geology of part of the Trinity Range in much less detail. Various reports by field agents of the Southern Pacific Company describe briefly the general geology in connection with individual mineral deposits (files of the Southern Pacific Company). An exhaustive report on perlite occurrences, markets, uses, etc., is to be found in the Southern Pacific Company's file for T. 28N., Rge. 31E., MDM., although the copy on hand at the field office is not legible as to author and date (see Supplemental Mineral Report, Sec. 19, T. 28N., R. 31E., MDM., SP Co. files).

GENERAL GEOLOGIC SETTING

The mapped area is in the Basin and Range province, and is characterized by mountainous terrain composed of metasedimentary rocks and igneous intrusive rocks of Mesozoic age, and a wide valley filled with Tertiary volcanic rocks and unconsolidated Quaternary lake sediments and alluvium. The Tertiary volcanic rocks also compose major portions of the Trinity Range on the west township, but are only sparcely represented in the foothills of the Humboldt Range on the east township. The Trinity Range has been built up largely as a result of volcanism, with elevation due to basin-range faulting being decidedly a secondary factor.

Triassic-Jurassic (?) Rocks

Metamorphosed sedimentary rocks of Triassic-Jurassic(?) age are indicated by the symbol "JRU" on the accompanying areal economic geology map. These strata have not been named, but are probably correlative with those of the Pershing area in the Humboldt Range, and the Raspberry formation and younger Upper Triassic to Jurassic(?) strata which have been mapped by personnel of the Mineral Survey of the Southern Pacific Co. throughout an extensive region to the north in the Angelope Range and Eugene Mountains. Correlations are based entirely upon similar lithology and probably continuity of outcrop to the north, as no guide fossils have been found. The beds at the Pershing area contain a much greater percentage of limestone, however.

Louderbach (1904) recognized Triassic fossils within these strata in the Humboldt Range, and relatively recent work by U.S. Geological

Survey personnel in the same range has resulted in the discovery of ammonites of Jurassic age (Wallace, et al., 1959) from strata probably correlative with those of the mapped area.

In the Pershing area and Stillwater Range of the Buffalo Mountain quadrangle, Wallace, et al., (1959) have mapped these rocks as Upper Triassic and Lower Jurassic in age.

These metasedimentary rocks are generally uniform in overall character. They are composed largely of dark-colored slates and phyllites with local thin interbeds or lenses of quartzitic sandstone and rare limestone. In many areas, the slates and phyllites are orange tan and calcareous, which is typical of the Raspberry formation and the shale of the Triassic-Jurassic strata in the Pershing area (Silberling, 1958, oral communication) in other areas. The phyllite is somewhat less abundant than the slate, and has the characteristic phyllitic sheen due to abundance of sericite which reflects much light. The quartzitic sandstone is generally gray or tan and fine-grained, and the limestone lenses are usually dark to black and fine grained. Neither the sandstone nor the limestone beds were differentiated on the accompanying map; however, local shale was noted separately from the undifferentiated metasediments in the S½SW¼ of Sectioh 13 of the east township. This shale is orange-tan, calcareous, and platy.

The Triassic-Jurassic(?) metasedimentary rocks are intruded by a granodiorite stock of Cretaceous (?) age in the northcentral part of the west township, and are overlain nonconformably by volcanic rocks of the "Truckee"*group of Miocene-Pliocene(?) age at various places in both townships.

The slates and phyllites exhibit diverse attitudes, which apparently are useless in delineating structural trends. The original shales

*Not a published group name.

and sandstones of the unit have been dynamically metamorphosed by the tectonic forces of the Late Mesozoic orogeny (Nevadan), and have been further metamorphosed by the thermal effects of the Cretaceous(?) intrusive masses. The development of hornfels in the Trinity Range is mentioned by Louderbach (1904). Compton (1959, written communication), will soon publish in the Bulletin of the Geological Society of America a paper on metamorphism of similar Mesozoic strata as observed in the Santa Rosa Mountains, north of Winnemucca, Nevada.

Cretaceous (?) Intrusive Rocks

The south portion of a granodiorite stock of Cretaceous (?) age composes approximately three square miles in the northcentral part of the west township, where it intrudes the metasedimentary strata of Triassic-Jurassic(?) age. Small granodiorite intrusives are located in Secs. 30 and 31 of the west township, and in Sec. 35 of the east township. The granodiorite is characteristically medium gray and medium crystalline. It is wholly crystalline and is composed of mostly sodic feldspar with a little potash feldspar and a few percent of quartz. Biotite is the most common accessory mineral composing an estimated 10 percent of the rock by volume.

The granodiorite disintegrates rapidly by weathering processes and forms a deep residual grus. Spheroidal weathering is locally pronounced. It is regarded as Cretaceous(?) in age because Roberts considers intrusives of this type in Nevada to be likely of this age (Kiersch, 1959b, written communication).

Tertiary (?) Volcanic Rocks

"Truckee" Group

The Truckee formation was first described by geologists of the 40th Parallel Survey (King, 1878). Type section is at "Kawsoh Mountain" in the lower end of the Humboldt River valley, but the exact location of the type section, as well as the description of the formation, was not clearly defined. These early workers located Miocene fossils in the formation, and later workers found Pliocene faunas and floras.

Van Houten (1956) described the Truckee and equivalent formations of Miocene and Pliocene age in Nevada. He discusses them in a general way as follows (p. 2801):

> "Throughout Nevada the most reliable stratigraphic datus in sequences of non-marine Cenozoic sedimentary rocks is a distinctive suite of tuffaceous upper Miocene to middle Pliocene deposits. For convenience of discussion, these rocks are referred to as the vitric tuff unit."

Van Houten further states (p. 2802):

> "Numerous names, including Esmerelda, Humboldt, and Truckee (Fig. 5), have been applied to the deposits. Except for the detailed study of Axelrod (in press, 1956), however, few attempts have been made to determine their proper application and extension."

Axelrod (1956) redefined the Truckee formation in the vicinity of Brady's Hot Springs to include rocks of a particular lithology of Pliocene age which were deposited in a specific basin. He named two new formations (Desert Peak and Chloropagus), which are of Mio-Pliocene age which were deposited in a specific basin. He named two new formations (Desert Peak and Chloropagus), which are of Mio-Pliocene age. Bonham and Schafer (1958, unpublished) extended Axelrod's new formations and defined a third new one, the Toll Rock formation of Miocene(?) age. In his abstract, Axelrod states:

> "Geological evidence demonstrates that these rock units were laid down in relatively local basins of deposition. Thus, the common practice of applying Late Tertiary formational names (i.e., Truckee, Esmeralda) over wide areas in the western Basin and Range province finds little support in field evidence. Up to now such usage has been based chiefly on evidence of age, rather than on lithic similarity."

If one agrees with Axelrod, the name "Truckee" as a formational unit should be restricted to define rocks of the same basin of deposition, lithology, and ge. If one accepts Van Houten's regional use of the term, the name "Truckee" (?) formation can be used for all upper Miocene to middle Pliocene volcanics and sediments which are characterized by the vitric tuff unit.

Since, as Axelrod indicates himself, it has been "common practice" to apply the Truckee formational name widely to include Mio-Pliocene deposits, he may have been wiser to keep the name Truckee for all deposits of this age, but upgrade the term to the rank of a group name including all of the various formations that will be named in the separate basins of deposition. He did not do so, but the writer prefers to use the term in this connotation.

The Toll Rock formation of Bonham and Schafer (1958), which they mapped in the adjacent township to the west, is equivalent to part of the "Truckee" group of the west township.

In addition to the perlite described above in the economic section of this report, three other lithologic units of the "Truckee" group were mapped: rhyolite, basalt, tuff, and limestone with limestone breccia. Large areas were mapped as undifferentiated "Truckee" on the map.

The rhyolite is the most common of these mappable units and is generally light tan to pinkish gray, and fine-grained with scattered phenocrysts. Primary flow bands are locally prominent. In places the rhyolite is highly colored and tuffaceous, and in other places it grades into perlite. The basalt is scarce, and is dark gray to black, dense, with scattered olivine phenocrysts visible to the naked eye. It occurs in rounded or subdued topography, in contrast to the younger basalt flows. The tuff is light gray to white, rhyolitic, fine-grained, soft, and massive to well-bedded. Much of it is obviously water-laid. That which was mapped in the east township contains undifferentiated reddish-brown rhyolite to andesite. The limestone is black, finely crystalline, and much of it appears to be a sedimentary breccia. It is limited in outcrop to the east-central part of Section 13 of the east township.

The "Truckee" group volcanic and sediments are nonconformable upon the generally more steeply-dipping metasedimentary rocks of Mesozoic age. The "Truckee" beds have been faulted and tilted during the block faulting of late Tertiary and early Quaternary times. They are overlaid nonconformably by unconsolidated lake and stream deposits of Pleistocene to Recent age, and locally by basalt.

Plio-Pleistocene Rocks

Basalt

This unit is limited in outcrop to prominent hills in Sections 10 and 15 of the west township. The basalt overlies nonconformably the volcanic rocks of the "Truckee" group. The rock is black, dense, and locally vesicular. The basalt dike in the E½ of Section 36 of the east township is possibly of the same age as these flows, but may be equivalent to the "Truckee" basalt.

Quaternary Deposits

Older Alluvium

Portions of the foothills of the Trinity Range in the west township were mapped as older alluvium and largely represent unconsolidated, poorly sorted debris transported by alope-wash during rainfall in the late Pleistocene epoch. The older alluvium is being dissected by the present streams during rare periods of runoff.

Older Alluvial Fan Deposits

Much of Section 11 of the west township is composed of older alluvial fans with much steeper slopes and coarser material than in the Recent fans. The unconsolidated rock debris is poorly sorted, and varies from silt through boulders. Shoreline features of ancient Lake Lahontan have been developed on the lower slope of the fan.

Lake Lahontan Deposits

The areal distribution of the sediments of late Pleistocene Lake Lahontan is greater than any other rock unit. These unconsolidated, well-sorted deposits compose the bulk of the valley fill below an ele-vation of 4,380 feet, which is the highest shoreline of the ancient lake. Thickness of these deposits is now known, but in the vicinity of Rye Patch reservoir, a few miles to the north, there are 200 feet of Lake Lahontan sediments and the base of the deposits is not exposed.

These horizontal deposits are largely silt, silty clay, and fine sand, but locally lenses and bars of sand and gravel occur, such as have been exploited in the NW$\frac{1}{4}$ of Section 23 of the east town-ship and to a lesser extent in Sections 27 and 31 of the west township. Probably the predominant lithology of the pebbles of these gravels is late from the Mesozoic metasedimentary rocks, which forms flat oval clasts. These are locally differentiated as beach terrace deposits. Elsewhere, they were not mapped separately and are included as a part of the undifferentiated Lake Lahontan deposits.

Calcareous tufa forms elongate outcrops in the western township, between about 4,110 feet and 4,200 feet elevation. The tuffa was apparently precipitated from the waters of Lake Lahontan, perhaps by the action of micro-organisms or algal growths at these elevations. The tufa is largely dirty-gray calcium carbonate with various crystal forms.

Alluvial Fan Deposits

In the east central part of the west township, alluvial fan deposits are being deposited beyond the mouth of South Trinity Canyon and elsewhere. These fans although extensive in plan view, are relatively shallow, and have a much more gentle gradient than the older fan in Section 11.

The unconsolidated, poorly sorted materials of the fan range from silt to cobbles with the finer grade sizes more abundant towards the toe of the fan. The fan is of post-Lake Lahontan age as it has destroyed the evidences of the lake's shoreline features.

Alluvium

The present stream channels are lined with unconsolidated, silt, sand, gravel, cobbles, and boulders. Locally these materials are cross-bedded. They grade into the alluvial fan deposits at the mouth of South Trinity Canyon. In places they are dissecting the older alluvium.

Silty Clay of Humboldt River

Unconsolidated, well-sorted flood-plain deposits of the Humboldt River form a sinuous belt of varying width which follows the meandering course of the river. These deposits form the lower terrace levels of the valley fill, with the upper levels being composed of Lake Lahontan sediments. The material of the flood plain varies from sand to clay, with silty clay and fine sand being the most abundant.

Playa Deposits

A small depression at the east quarter corner of Section 11 of the west township contains playa deposits consisting of silty clay and fine sand of Recent age.

Eolian Deposits

Wind-blown deposits, largely sheet sand, occur sparingly along the southern border of the mapped area.

STRUCTURAL FEATURES

The Mesozoic metasedimentary rocks of the area have been involved in folding and dynamic metamorphism which accompanied the Late Mesozoic (Nevadan) orogeny. This orogeny preceded intrusion of the granodiorite stocks. After a prolonged period of erosion, during which the products of erosion were removed from the region by streams probably draining into the Pacific Ocean, the volcanic rocks of the Tertiary Period were deposited. This volcanism was accompanied by normal faulting of the early phase of the basin-range block faulting. The later phase of this faulting occurred during Pliocene and early Pleistocene times, and is responsible for the present major features of the topography.

Evidences of the Late Mesozoic orogeny include the deformed and metamorphosed strata of Triassic-Jurassic(?) age. No mappable folds or thrust faults were observed during the mapping, but probably would be located by more detailed work. Location of thrust faults is difficult because of the monolithologic character of the Mesozoic rocks, and the fact that they tend to slip along bedding-planes rather than form conspicuous breccia zones.

The basin-range block faulting is represented by normal faults which trend northeast, north-south, northwest and locally east-west. The larger of these is parallel to the northeast trend of the front of the Trinity Range in the west township. This fault has been downthrown on the southeast side. Smaller faults appear to have offset rhyolite dikes in the northwest part of the west township. Others have tilted and displaced the "Truckee" group volcanic rocks in the west-central part of this township.

Some of the smaller normal faults have been mineralized with silver and a little gold and copper. These mineralized faults generally trend northeast at the mined area in the NW¼ of Section 3 of the west township, and at the Willard Mine area of the east township, although at the latter location some weakly mineralized zones follow northwest faults.

FIELD WORK

Man-Days

A total of 19 man-days was spent in the field on these two townships.

Geophysics

The junctions of the major streams below the contact of the granodiorite and the metasedimentary rocks were examined at night with an ultraviolet light in an effort to locate evidences of tungsten mineralization. No positive results were obtained. Selected samples were tested with a scintillometer. One sample from the east township was found to be radiometrically anomalous. Radiometric measurement of this sample by Union Assay Inc., (1957c APPENDIX "D") indicated a content of 0.03 percent equivalent U_3O_8.

RECOMMENDATIONS

Twp. 28N., Rge. 32E.

The potential value of Sections 1, 11, 13, 23, 27, 28(part), 33, and 35 for construction materials (sand and gravel) should be recognized in any future negotiations concerning these lands. Some of these Sections will probably be crossed by the new U.S. Highway 40, which is to be rebuilt to freeway specifications at some future date, and all are very favorably located with respect to the Southern Padific railroad and the present U.S. Highway 40. Section 23 (NW¼) contains sand and gravel which has been used in the past for road-building purposes, and therefore is of definite commercial value. The tuff deposits in Section 35 should be regarded as having potential value for light weight or plaster aggregate in view of their favorable location.

Twp. 28N., Rge. 31E.

No recommendations are made for this township, and no further work is necessary.

Donald E. Pruss

William A. Oesterling

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TELEPHONE 3-3302

APPENDIX "A"

T28N, R31-32E VOUCHERED

Hand Sample Serial 19222-35

ASSAY REPORT

DEPT. NO.

UNION ASSAY OFFICE, Inc.

J. V. SADLER, President
A. C. SELBY, Vice-Pres. & Treas.
Lily M. Hottinger, Secretary

Salt Lake City 10, Utah

Mine SOUTHERN PACIFIC COMPANY Southern Pacific Company

Land Department

RESULTS PER TON OF 2000 POUNDS July 18, 1957

Number	GOLD Ozs. per Ton	GOLD VALUE	SILVER Ozs. per Ton	LEAD Per Cent Wet	COPPER Per Cent Wet	Per Cent Mn	ZINC Per Cent	Per Cent As	TUNGSTIC OXIDE Per Cent	Per Cent WO_3	LIME Per Cent	Per Cent
R-03-28-31 Pr 54(a)	None		1.8		0.07	0.04		0.24		None		
R-03-28-31 Pr 53(a)	0.040		0.9		0.01	0.07		0.10		None		
R-03-28-31 Pr 52(a)	None		0.2		None	0.06		0.07		None		
R-03-28-31 Pr 51(a)	0.020		0.3		None	0.06		0.05		None		
R-03-28-31 Pr 50(a)	None		0.4		None	0.01		0.02		None		
R-03-28-31 Pr 49(a)	None		0.4		0.03	0.03		0.02		0.02		
R-03-28-31 Pr 48(a)	0.660		0.4		0.02	0.04		0.05		0.03		
R-03-28-31 Pr 47(a)	0.220		28.3		0.11	0.03		0.02		None		
R-03-28-31 Pr 46(a)	0.510		6.9		0.04	0.01		0.19		None		
R-03-28-31 Pr 45(a)	0.020		0.2		None	0.04		None		None		
R-03-28-31 Pr 44(a)	Trace		5.2		0.037	0.03		0.02		None		
R-03-28-31 Pr 43(a)	0.030		0.2		None	0.03		1.21		None		
R-03-28-31 Pr 42(a)	0.230		4.1		0.037	0.01		0.05		0.02		
R-03-28-31 Pr 41(za)	Trace		2.2		0.031	0.04		None		0.03		

Remarks These samples are from NW¼ Sec. 3 (not owned by S.P. Co.)

Charges $ 182.00

[signature]

APPENDIX "B"

353-24
Sacramento, July 10, 1957

SUBJECT: Water Samples from Southern Pacific Land Company

Mr. G. A. Kiersch:

Mr. Wm. A. Oesterling wrote to us June 19, 1957 advising that four water samples were being forwarded.

These waters were received during the latter part of June and are identified in the accompanying tabulation.

It is noted that the request for analytical data this time includes the total dissolved solids. Percent of dissolved solids is desired also and it is felt that perhaps a word of explanation is advisable in this connection. Following customary practice the various components are given in parts per million and then as a percentage based upon the dissolved solids, as requested. While the latter figure is not included as a total in our compilation it will be observed that a summation is not equivalent to the total dissolved solids as presented in our tabulation. This discrepancy is due to the fact that when the bicarbonates are taken down to dryness some of the weight is lost thereby as illustrated by the following equation. This equation illustrates the changes which occur when calcium bicarbonate is converted to calcium carbonate by the loss of carbon dioxide and water $Ca(HCO_3)_2 \rightarrow CaCO_3 + H_2O + CO_2$.

The bicarbonate ion is determined by a titration in the liquid phase and therefore does not appear in the results shown for Total dissolved solids.

As has been our customary practice Spectrographic means were employed for Molybdenum, Antimony, Silver, Cobalt and Zinc determinations.

J. G. Maurer

cc: Mr. P. V. Garin
Mr. Wm. A. Oesterling

UL:mp

TABULATION

This sample is not located on map. (R-03-28-31-Pr)

	R-26-26-29-Os 45 (Wa-1) Spring Water		R-03-28-31-Pr 29 (Wa-1) Spring Water		R-05-25-30-La 60 (Wa-1) Lake Water		R-19-25-30-La 61 (Wa-2) Well Water	
	PPM	: %	PPM	: %	PPM	: %	PPM	: %
Iron as Fe	0.2	:0.027	0.2	:0.02	0.2	:0.005	0.2	:0.0037
Aluminum as Al	Trace	:	Trace	:	0.2	:0.005	Trace	:
Silica as Si	22.0	:2.99	17.0	:1.32	33.0	:0.83	28.0	:0.51
Molybdenum as Mo	None	:	None	:	None	:	None	:
Silver as Ag	Trace	:	Trace	:	Trace	:	Trace	:
Antimony as Sb	None	:	None	:	None	:	None	:
Arsenic as AsO_4	None	:	0.05	:0.004	0.5	:0.012	None	:
Copper as Cu	None	:	None	:	None	:	None	:
Magnesium as Mg	27	:3.67	42	:3.25	1	:0.025	2	:0.037
Cobalt as Co	None	:	None	:	None	:	None	:
Zinc, as Zn	None	:	None	:	None	:	None	:
Sodium as Na	98	:13.32	103	:7.98	1353	:33.97	1908	:34.90
Potassium as K	15	:2.04	Trace	:	22	:0.55	40	:0 .73
Calcium as Ca	77	:10.46	190	:14.72	6	:0.15	7	: 0.13
Fluorine as F	1.1	: 0.15	0.6	: 0.05	7.2	:0.18	7.2	: 0.13
Boron as B	1	: 0.13	1	: 0.08	11	:0.28	25	: 0.46
Chlorine as Cl	151	:20.55	271	:21.00	1357	:34.10	2062	:37.71
Sulfate as SO_4	111	:15.10	374	:28.90	292	: 7.23	415	: 7.59
Bicarbonate as HCO_3	232	:31.56	293	:22.68	619	:15.55	809	:14.77
Carbonate as CO_3	None	:	None	:	282	: 7.08	168	: 3.07
Unassigned	Pb Trace		Pb Trace		Pb Trace		-	-
Total dissolved solids	621	:	1244	:	3528	:	4956	:
pH	7.75	:	7.45	:	9.05	:	8.40	:

Telephone 3-3302

APPENDIX "C"

Hand Sample Serial 17085-17100

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

J. V. SADLER, President
A. C. SELBY, Vice-Pres. & Treas.
Lily M. Hottinger, Secretary
Salt Lake City 10, Utah

Mine Southern Pacific Company, Land Department

RESULTS PER TON OF 2000 POUNDS June 24, 1957

VOUCHERED
DEPT. No. ....
AUDIT No. ....

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	~~ZINC~~ Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
						Cobalt					
R-23-26-30-OS-39-A	None	0.4									
R-16-26-29-OS-40-A	Trace	0.2									
R-15-26-30-OS-41-R	Trace	0.9									
R-15-26-30-OS-42-A	0.040	42.1		0.12							
R-14-26-30-OS-43-A	Trace	1.7									
R-06-26-29-OS-44-A	Trace	0.2									
R-34-26-29-OS-45-A				0.02		None					
R-6-27-29-PR-19-1A	Trace	0.2		0.02							
R-6-27-29-PR-19-2-A	None	0.2		0.01							
R-03-28-31-PR-24-A	0.310	11.9		0.08							
R-03-28-31-PR-23-A	Trace	0.5		0.02							
R-03-28-31-PR-25-A	Trace	1.8		0.05							
R-03-28-31-PR-22-A	0.140	128.1		0.66							
R-03-28-31-PR-26-A	0.020	0.1		0.07							
R-05-27-30-PR-27-A	Trace	0.2									
R-18-27-30-PR-28-A	Trace	0.1									

APPENDIX "D"

Telephone EMpire 3-3302

Hand Sample Serial 14938-43

VOUCHERED

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

J. V. SADLER, President
A. C. SELBY, Vice-Pres. & Treas.
LILY M. HOTTINGER, Secretary
Salt Lake City 10, Utah

Min Southern Pacific Company DEPT. No. 97

AUDIT No. ________

RESULTS PER TON OF 2000 POUNDS May 21, 1957

NO.	GOLD Ozs. per Ton	SILVER Ozs. per ton	LEAD Per Cent Wet	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent Mn	Per Cent Sb	VALUE GOLD
R-25-28-32-PR 1(A)	Trace	0.1		None							None	
R-25-28-32 PR 2(A)	Trace	0.1		None							None	
R-25-28-32-PR 3(A)	Trace	0.05		None								
R-19-27-30-PR 4(A)	Trace	0.1		None						None	None	
R-00-28-32-PR 5(A)	Trace	0.1										
R-31-27-29-PR 6(A)	Trace	0.05	None	None								

Remarks R-00-28-32 PRS U308 radio assayer 0.03

Charges $ 27.00

[signature]

Southern Pacific
Land Company

Southern Pacific Building • One Market Plaza • San Francisco, California 94105 • (415) 362-1212

NATURAL RESOURCES

W. F. HERBERT
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ASSISTANT TO GENERAL MANAGER

W. A. OESTERLING
CHIEF GEOLOGIST
W. T. SAPLING
MANAGER RESOURCE PROJECTS

February 22, 1979

3970.19

Mr. Jeff Hulen
Earth Sciences Laboratory
391 Chipeta Way - Suite A
Salt Lake City, Utah 84108

Dear Mr. Hulen:

In response to your telephoned request of this morning, we have pleasure in enclosing herewith the two maps you indicated, viz:

Townships 27 & 28 North, Ranges 33 & 34 East, MDM.

Kindly forward us remittance for $10.00 payable to Southern Pacific Land Company, being cost of these two maps @ $5.00 each.

Thank you for your order.

Very truly yours,

W. A. Oesterling

W. A. OESTERLING pmc
Chief Geologist

Encl.

Southern Pacific Land Company

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NATURAL RESOURCES

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MANAGER RESOURCE PROJECTS

January 9, 1979

3970.17-A

Mr. Eric Shunsacker
Earth Science Lab U.U.R.I.
391 Chipita Way - Suite A
Salt Lake City, Utah 84108

Dear Mr. Shunsacker:

In accordance with your telephone request, by separate mail we are sending you Southern Pacific "Minerals for Industry" for Northern Nevada and Northwestern Utah, and geologic map of the Beowawe area.

Please forward remittance payable to Southern Pacific Land Company for $15.00 to this office to cover the cost of the book and map.

Thank you for your order.

Very truly yours,

W. A. Oesterling

W. A. OESTERLING
Chief Geologist

1/16/79 ORDERED MAPS COVERING T. 27 & 28 N., R. 31 & 32 E BY PHONE for COLADO
JHT

1/18/79 THESE ARRIVED JHT wait for invoice to pay?