Ground Water Conditions in a Portion of the San Jose - Bluewater Valley in the Vicinity of Grants, New Mexico.

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January, 1938.

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Acknowledgments

Following a request by the Bureau of Indian Affairs, the writer was assigned to make a reconnaissance investigation of the ground-water conditions in a portion of the valley of the Bluewater-San Jose River between Bluewater and McCartys, Valencia County, New Mexico. Mr. Paul V. Hodges, Hydrographic Engineer, and Mr. Robert H. Rupkey, Engineer, of the Indian Irrigation Service, Office of Indian Affairs, greatly aided the investigation by their courtesy and intimate knowledge of the region. The map of the part of the valley investigated, included in this report, was prepared under their direction in the offices of the Indian Irrigation Service.

Geography

Bluewater Creek heads at the crest of the Zuni Mountains, near Sawyer, and flows north and northeast down the north slope of the mountains. At the junction with Azul Creek it turns abruptly to the east and enters the Bluewater Canyon. The canyon has an east-west trend and is six miles long. The Bluewater Dam, of the Bluewater-Toltec Irrigation Company, is located at the head of the canyon.

From the mouth of the canyon to Horace Station the Bluewater Valley has a southeastward trend paralleling the Zuni Mountains. Below this point, the stream is generally called the San Jose River. From Horace Station to Laguna it flows almost due east. At Laguna it again turns to the southeast, joining the Rio Puerco six miles southeast of Suwanee.

The Atchison, Topeka & Santa Fe Railway follows the San Jose from a point southeast of Suwanee to Bluewater. From Bluewater west the railroad continues on in the valley of Mitchell Draw which extends to the continental divide at Gonzales. U. S. Highway 66 parallels the railroad through the valley.

Physiography

The Zuni Mountains in which Bluewater Creek heads is a dome with a northwest-southeast elongation. The beds on the northeast slope of the dome dip gently. The portion of San Jose-Bluewater valley between Bluewater and Horace Station and the valley of Mitchell Draw northwest of Bluewater are wide flat-floored subsequent valleys eroded in the soft Triassic shales. Two miles above Grants the valley is constricted between the dip slope of the resistant Chupadera formation to the south and a lava-capped mesa which rises 700 feet above the valley floor north and west of the town.

Below Grants another wide flat-floored subsequent valley joins the San Jose from the southwest. This valley, known as Malpais Valley, is also underlain, beneath late lava flows, by soft Triassic shales.

A few miles above Horace Station the San Jose ceases to parallel the strike of the beds and cuts transversely across the structure. Between Horace Station and Laguna the valley crosses a shallow syncline. Through the upper part of this stretch from Horace Station to McCartys the valley floor is less than one-half mile wide and the valley walls are quite steep.

Stratigraphy

Permian

The following discussion of the pre-Quaternary stratigraphy is based on the work of Darton [1].

[1] Darton, N.H., Red beds and associated formations in New Mexico, Geol. Survey Bull. 794, pp. 137-148, 1928.

In the upper part of the Bluewater Valley, from Sawyer to a point a few miles above the Bluewater Dam, the valley is underlain by the Abe Sandstone. The formation is 600 feet thick near Sawyer and consists principally of brown-red sandstone with a 40-foot brown conglomeratic bed at the base, and 25 feet of blue-gray limestone above the conglomerate.

The Chupadera formation overlying the Abe consists of buff and red sandstones and subordinate limestone beds. The limestone that caps the formation in this area is over 80 feet thick and forms the long dip slope on the northeast side of the Zuni Mountains. The Chupadera dips beneath the Bluewater-San Jose Valley to the northeast and beneath the wide flat Malpais valley to the east. The canyon of Bluewater Creek is cut in the Chupadera formation.

Triassic

Underlying the wide portion of the Bluewater-San Jose Valley, between Horace and Bluewater, and beneath the lava in Malpais Valley is a thick succession of Triassic beds. The beds in the San Jose Valley below Grants and in Malpais Valley are poorly exposed, being almost everywhere covered by recent lava or wash from the hillsides. The beds consist principally of shales with a dominant red color, but also contain some sandstones and variegated shales.

Near Bluewater the Triassic beds are better exposed and can be separated into three formations. The basal Triassic formation is the Moenkopi. Near Bluewater, it consists principally of soft red and purplish shales with minor amounts of gray and buff shale and gray sandstone. It underlies the flats south of the lava flow near Bluewater but is poorly exposed. A few miles northwest of Bluewater it is well exposed along the road to the Bluewater Dam. The Moenkopi formation is about 600 feet thick near Bluewater.

Overlying the Moenkopi is a sandstone which Darton _/ regards as a repre-

_/ Idem. pp. 143-144

sentative of the Shinarump conglomerate. It forms a conspicuous ridge northwest of Bluewater and there is a small exposure on the south face of the mesa west of Grants.

The Chinle formation overlies the Shinarump and consists of about 900 feet of reddish maroon shales and sandy clays with thin sandstone. _/ It under-

_/ Idem. p. 144

lies the wide flats north of the river between Bluewater and Horace Station.

Jurassic

The Jurassic representatives in the area outcrop in the cliff east of Malpais Valley and also in the cliffs north of and parallel to the railroad from Horace almost to Gallup. They cross the San Jose beneath the lava about two miles west of Horace Station.

In the Bluewater-Grants region the Wingate sandstone, the lowest formation usually assigned, though somewhat doubtfully, to the Jurassic system, consists of 160 feet of reddish brown crossbedded sandstone, with a red

earthy phase at the base. It is exposed in the cliffs forming the north wall of the valley north of Bluewater and in the first low ridge northeast of Grants. The upper part is exposed at the foot of the cliffs east of Malpais Valley five miles south of Horace Station.

The Morrison formation which succeeds the Wingate / varies consider-

/ The correlation of the Jurassic beds follows: Baker, A. A., Dane, C.H., and Reeside, J. B. Jr., Correlation of the Jurassic beds of parts of Utah, Arizona, New Mexico, and Colorado. U.S.Geol. Survey, Prof. Paper 183, 1936.

ably in character and thickness along the San Jose. At its base in this area, there is a thin but persistent impure gray limestone called the Todilto limestone member of the Morrison formation. In the Bluewater-Grants area it is 12 - 18 feet thick. It is present in the ridge north of the railroad above Bluewater and is exposed in a low ridge northeast of Grants. Five miles south of Horace Station on the east side of the Malpais valley it has a limited exposure in a low ridge beneath the high cliffs forming the east wall of the valley. The remainder of the Morrison formation consists of a lower unit of cross-bedded buff to white sandstone and an upper unit of greenish-gray clay with some maroon clay and thin sandstones. The lower crossbedded sandstone is from 100 to 200 feet thick in the Bluewater-Grants area and was mapped by Darton / as the Navajo sandstone. It forms the cliff east of

/ Darton, N. H., op. cit., pp. 35, 145

Malpais Valley and is present in the ridge north of the San Jose-Bluewater River from Horace to Bluewater. It passes under the lava in the floor of the San Jose, 2 miles west of Horace Station. The upper unit of clays and thin limestone is lacking in the exposures in the cliffs south of Horace Station but is present in the ridge north of the San Jose-Bluewater Valley.

Upper Cretaceous

Disconformably overlying the Morrison are 60 to 100 feet of medium to coarse textured sandstones with some interbedded gray shales which have been referred to the Dakota sandstone. Locally the formation contains thin conglomeratic beds. The Dakota caps the ridge east of Malpais Valley and the ridge north of the San Jose Valley. The top of the formation passes under the recent lava on the valley floor at the highway bridge two miles west of Horace Station. From that point to a point a short distance below McCartys, the contact between the Dakota and the overlying Mancos shale is concealed beneath the lava.

The Mancos shale consists for the most part of gray and greenish-gray shales but has a number of 20-to 40-foot sandstone beds in the lower 300 feet. The Mancos is spread over a wide area north and south of the San Jose between Cubero and Horace Station and north of the ridge forming the north wall of the San Jose-Bluewater Valley above Horace Station. Only the lowest beds of the formation reach the valley floor between Horace Station and a point a short distance below McCartys.

Quaternary

The old valley of the Bluewater-San Jose River was excavated to a depth of 50 to 100 feet below the present valley floor. The valley has been filled to its present level by late Quaternary deposits consisting principally of basalt lava flows with varying amounts of silt, clay, sand and gravel.

At the base of the valley fill over most of the Bluewater-Grants area there are stream deposits of sand, clay, and gravel averaging 10 to 20 feet in thickness. Overlying the sands and gravels are a number of lava flows which make up the greater part of the valley fill. In the Bluewater vicinity the well drillers report 90 feet of lava (locally called malpais) with

no interbedded sand or clay. The log of the railroad well at Bluewater however shows 90 feet of basalt in two flows separated by thin tuff and red clay./ It is probable that there are at least two lava flows in the

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/ Darton, N. H., op. cit., p. 148

Bluewater area and that the sedimentary deposits encountered in the railroad well occur only in scattered patches over the lower flow and are likely not to be encountered in drilling. At Grants three lava beds were encountered in some of the wells and two beds in others. The log of the railroad well at McCartys shows one lava bed between 66 and 80 feet below the surface. The lava covers the entire floor of Malpais Valley and wide areas in the San Jose-Bluewater Valley near Bluewater and south and southeast of Grants. It consists of vesicular basalt, and wherever it is exposed its surface is extremely rough and broken. There are numerous small depressions caused by the collapse of the lava crust above subterranean channels from which the molten lava drained.

There are at least two sources of the basalt in the San Jose-Bluewater Valley. One source is El Tintero crater, six miles north of Bluewater. The lava in the Bluewater area came from this crater. Between Teltec and a point two miles west of Grants no basalt is exposed at the surface. It appears that the most recent flow from El Tintero did not extend east of Teltec. The older flow or flows from El Tintero extended as far east as Grants and possibly extended beyond McCartys.

The flow covering the floor of Malpais Valley and the area near Grants came from one of the craters to the south. The basalt encountered in the railroad well at McCartys may have come from either El Tintero crater or from the south via Malpais Valley.

Interbedded in the basalt in the Grants area and in at least one point in the Bluewater area are silts and clays with little coarse material. In the railroad well at the pump house in Grants at least 13 feet of clay was encountered between the two basalt flows penetrated.

Along the east edge of Malpais Valley and occupying the entire floor of the San Jose Valley between Horace Station and McCartys is a very recent flow of lava. It consists of vesicular basalt like the older flows in the area. However, it has a dense black color in contrast to the older flows which have a slight reddish cast on exposed and oxidized surfaces. The recent flow in places forms a narrow ridge with a rounded crest, but for the most part it has been badly broken by flow movement and is made up of huge blocks crumpled and piled together in a haphazard manner. In the San Jose valley between Horace Station and McCartys there are numerous small depressions formed by the collapse of the crust of the lava.

Forming a discontinuous mantle over the lavas on the valley floor are recent deposits of silt and fine wind-deposited sand. From Bluewater to Toltec the channel of Bluewater Creek is lined by silt and clay and from Toltec to a point two miles west of Grants, the entire valley floor is covered by deposits of this type. From Grants to a point four miles west of Horace Station the channel again has a silt and clay lining. From this point east to McCartys the silt mantle is lacking or occurs in scattered patches along the channel or in depressions in the lava.

Structure

The rocks underlying the San Jose-Bluewater Valley above Grants dip gently to the northeast. Below Grants the beds dip more nearly east. Beneath Malpais Valley the dip is east-southeast. Between Horace Station and Laguna the San Jose crosses a shallow syncline.

A fault striking northeast passes through Grants. Northeast of Grants the Dakota sandstone east of the fault is dropped about 1000 feet. Near Grants the fault passes beneath the lava but seems to appear again on the west side of a wide alluvial embayment in the dip slope of the Chupadera west and southwest of San Rafael. Displacement is not apparent in the Chupadera but the beds are abruptly cut off where they form the margin of the embayment. Further southwest there is a distinct depression in line with the fault which trends diagonally across a number of stream valleys. (See appended map of Portion of the Bluewater and San Jose Valley.)

Hydrology

Surface Waters

It is reported that prior to the construction of the Bluewater Dam the perennial stretch of Bluewater Creek ended in Bluewater canyon. Below the canyon the Bluewater was a surface-fed intermittent stream flowing during the spring runoff and after rains. Since the construction of the Bluewater Dam the flow on Bluewater Creek has been completely controlled. From the canyon to Grants the stream has become ephemeral, flowing only after local rains or heavy rains on Mitchell Draw, which drains the wide valley west of Bluewater.

In December 1937, there was a small flow in the San Jose from Grants to a point one mile west of Horace Station. At that point the flow was diverted for irrigation and the channel below was dry to the railway bridge at Horace Station. One hundred yards below the railway bridge at Horace Station, springs appear in the channel, and from there down to the diversion below McCartys the San Jose has a perennial spring-fed flow.

Malpais Valley has no established through stream courses. Over the valley floor short streams lead to depressions. The drainage of Malpais Valley is underground through the lava and associated sediments of the valley fill.

Ground Water

The principal aquifer in the Bluewater-San Jose Valley between B. and McCartys is the valley fill and most of the wells in the valley dr from that source. A few wells along the southern edge of the valley f near Bluewater and between Bluewater and Grants apparently draw their s from sandstones in the Chupadera.

In the vicinity of Bluewater the water table is about 80 to 90 fee low the surface and is, according to drillers, encountered in sands and gravels below the basalt. Eastward, down the valley, the depth to water decreases and is only 6 to 10 feet in the vicinity of Grants. Water is developed in the basalt in large quantities, however, unless a cavern is encountered. One of the well drillers in the area reports that wells can be bailed dry unless they penetrate the gravels underlying the basalt. Between Grants and Horace Station there are no wells and therefore the depth to the water table could not be determined. From Horace Station to McCartys numerous springs discharge into the channel of the San Jose and many depressions in the lava intersect the water table from 6 to 10 feet below the surface.

From Bluewater to the Schmaltz well, four miles west of Grants, the gradient of the water table averages 10 feet per mile. From the Schmaltz well to Grants the gradient is 5 feet per mile. From the springs in the San Jose channel below the bridge on the San Rafael road south of Grants to the west well of the Santa Fe Railway, a distance of 0.4 mile, the gradient is 16 feet per mile. In the next half mile, to the east well of the railroad, the gradient abruptly increases to 36 feet per mile. From Grants to Horace Station the average gradient is 20 feet per mile. In the two-mile stretch below Horace Station the gradient is 17 feet per mile.

There is an obstruction in the valley fill at Grants where the abrupt break in the water-table gradient takes place. Protruding from the lava south of Grants are three small outliers of Chupadera limestone. They appear to be a sliver of Chupadera caught up by the fault which passes through Grants and San Rafael. The outliers in the narrow valley between Grants and the foot of the dip slope of the Chupadera form a partial ground water dam. Through the constricted portion of the valley the gradient is necessarily greater then in the wider valley above.

A number of small water table springs issue in the channel of the San Jose at Grants, and a series of springs between Horace Station and McCartys maintain a perennial flow in the stream from Horace to the diversions on the Acoma and Laguna Grants. Both series of springs occur along constricted portions of the old valley. The amount of valley fill in the narrow stretches is not great enough to carry all the water brought to them through the wider stretches above, and consequently some of the ground water is forced to the surface.

The only other spring observed is the Ojo del Gallo at San Rafael, 2½ miles south of Grants on the west edge of Malpais Valley. This spring, unlike those at Grants and below Horace Station, does not derive its water from the supply stored in the valley fill. It is an artesian spring fed by one or more of the sandstones in the Chupadera or Abo formations. Water from snows and rains in the Zuni Mountains to the west and southwest is absorbed by the sandstones at their outcrop near the crest of the mountains. It percolates down the dip of the beds and rises to the surface at San Rafael along the fault that passes through Grants and San Rafael. It is possible that there are other openings to the artesian aquifer along this fault and that the water issuing through such openings is lost in the valley fill before reaching the surface.

Source of the Ground Water in the Valley Fill

There are probably four sources of the ground water in the valley fill in the San Jose-Bluewater valley. They are:

1. Spring run-off from the Zuni Mountains via the Bluewater River.

This source of supply has ceased as such since the construction of the Bluewater Dam. Before the construction of the dam some seepage undoubtedly took place during the run-off season. The amount of water annually contributed to the ground water from this source however was probably not great, as the channel of the stream over most of its course is lined by relatively impervious clays and silts. In a few short stretches near Bluewater, the lava is exposed in the channel and there was opportunity for considerable seepage loss.

2. Local precipitation on the San Jose Valley and precipitation on tributaries such as Mitchell Draw above Bluewater and Malpais Valley south of Grants.

Where the lava is exposed probably a large portion of the precipitation finds its way to the water table. Over the area covered by the mantle of silt and clay there is probably little penetration. The run-off after heavy showers is rapid and seepage from the streams in flood is probably small. In Malpais Valley a part of the precipitation finds its way into depressions, the bottoms of which have been sealed by silt and clay, and is there in part evaporated. The remainder of the precipitation percolates underground to join the ground water in the valley fill of the San Jose Valley.

3. Irrigation losses near Bluewater and Toltec.

The water that comes down Bluewater Creek during the spring run-off is now stored in the reservoir and used for irrigation except that which is lost

by evaporation or seepage. The proportion of the water applied in irrigation that reaches the water table could not be determined. It appears, however, that more water is contributed to the ground water reservoir by irrigation losses than was formerly contributed by seepage from the stream during the spring run-off. The water level in a number of wells in the vicinity of Bluewater is reported to have risen in the past six years. Mr. Ames Titjen, a well driller in Bluewater, reports that the water level in his house well has risen 8 feet since 1931.

4. Ojo del Gallo at San Rafael.

The spring at San Rafael is utilized to irrigate an area of about 1200 acres south of San Rafael. East of the spring and the irrigated belt is a swampy area of 1000 or 1200 acres. When not irrigating the water is allowed to waste over the swamp. During the winter the entire flow of the spring, estimated at seven second-feet, is disposed of in the same manner. Undoubtedly considerable water is added to the ground water supplies in the valley fill from this source.

In addition to seepage from the Ojo del Gallo waste, some water must be fed directly into the valley fill by this spring and possibly some water rises into the valley fill at other places along the fault.

Summary

The San Jose-Bluewater Valley between Bluewater and McCartys was excavated to a depth from 80 to 100 feet below the present valley floor, principally in soft Triassic shales. Opposite Grants and from Horace Station to McCartys the stream flowed over more resistant rocks and the valley was consequently constricted. During late Quaternary and in part Recent time, the valley was filled to its present state by basalt lava flows and sand, gravel, silt, and clay. The basalt makes up the greater part of the valley

fill but there are interbedded silts and clays and the lava flows in the deeper parts of the valley are underlain by 10 or 12 feet of sand and clay.

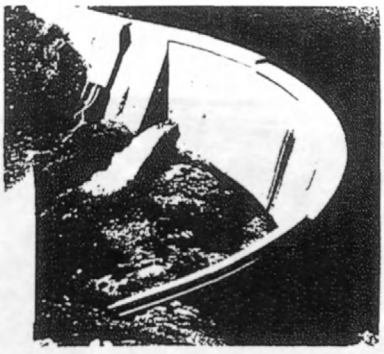
The valley fill constitutes the principal aquifer in the area. The basalt, while vesicular and considerably broken by flow movement, does not yield water in large quantities unless cavities are encountered. As a rule good wells penetrate the gravel at the base of the fill.

The depth to the water table ranges from about 80 feet, in the vicinity of Bluewater, to only about 10 feet or less at Grants and in the part of the valley from Horace Station to McCartys. There is a sharp break in the gradient of the water table at Grants, where the old valley is constricted by outcrops of resistant rocks.

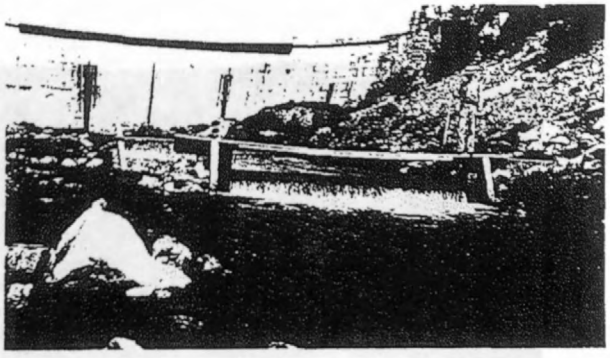
A part of the ground water stored in the valley fill is discharged through springs in the San Jose channel at Grants and between Horace Station and McCartys. In both cases a constriction of the valley causes the springs to appear.

Ojo del Gallo, an artesian spring located on the north edge of the village of San Rafael, issues along a northeast-southwest fault which passes through Grants and San Rafael. The aquifer that feeds the spring is one or more of the sandstones in the Abo or Chupadera formations. Irrigation waste during the summer and the entire spring flow during the winter form a swamp east of the springs on the floor of Malpais Valley. Seepage from the swamp makes an important contribution to the ground water in the San Jose Valley. Other artesian water along the fault between San Rafael and Grants may feed directly into the valley fill without reaching the surface.

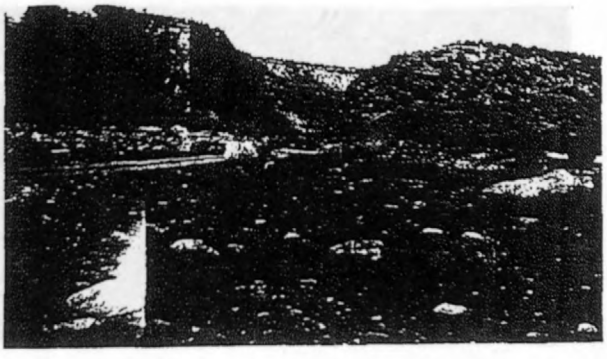
Waste and irrigation losses from Ojo del Gallo with possible underground leakage into the valley fill from other openings along the fault are believed to be the principal source of the water which feeds the springs between Horace Station and McCartys. Other sources, in order of importance, are irrigation losses in the Bluewater-Toltec District and precipitation directly upon areas in which the lava is exposed.



Bluewater Dam - August 19, 1937



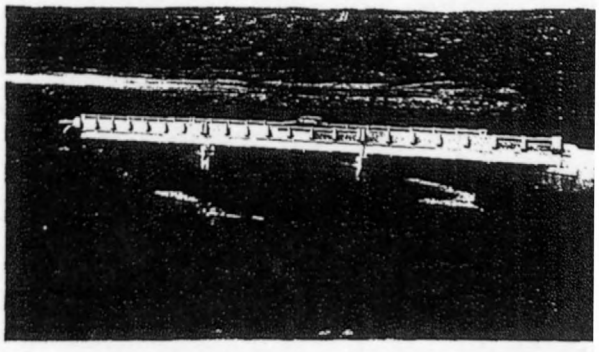
Weir Below Dam. 39 S.F., August 19, 1937



Lower End of Bluewater Canyon

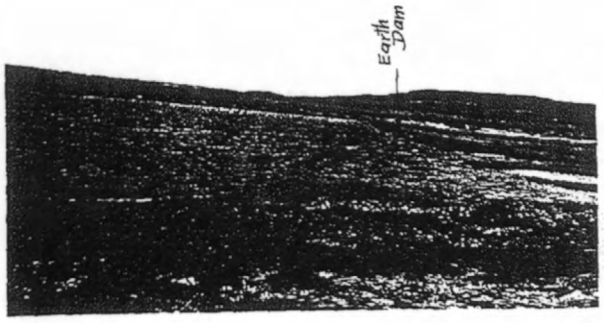
Three miles southeast of Grants. 0.2 S.F.

Near Railroad Overpass. 0.2 S.F.
See p. 340



At High S.E. of Railroad overpass. 0.2 S.F.

Stream from Ojo del Gallo flowing in
Outlet channel just above junction
with Rio San Jose, March 6, 1938
See Page 341

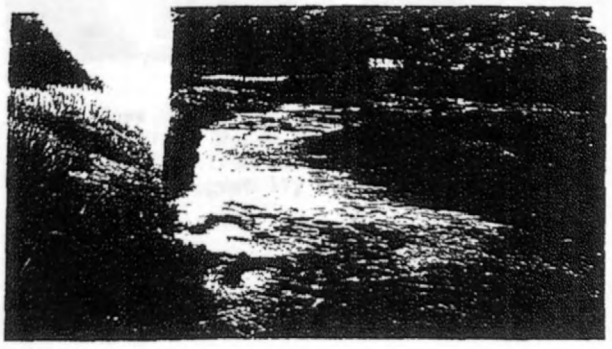


Reservoir East of San Rafael. Jan. 19, 1938
See p. 339

Canal Diversion from reservoir
3.5 - 4.0 S.F. Jan. 19, 1938

Outlet channel below reservoir.
1.7 S.F. Jan. 19, 1938
See p. 339

Lava on narrow ridge of recent flow
2 to 2½ miles southwest of Horace



Rio San Jose Channel under R.R. Bridge near Horace
Upstream View 4 S.F. March 6, 1938

See p. 341

San Jose Channel under R.R. Bridge near Horace
Upstream View. Dry August 17, 1937

See p. 341

San Jose Channel at Head of Springs below
R.R. Bridge near Horace
Downstream View from Same Point as Above Picture
August 17, 1937.

Lava Flow East of Horace

Water Standing in Potholes