

EXPLORATIONS AND SURVEYS FOR A RAILROAD ROUTE FROM THE MISSISSIPPI RIVER TO THE PACIFIC OCEAN.

WAR DEPARTMENT.

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ROUTE NEAR THE THIRTY-FIFTH PARALLEL, UNDER THE COMMAND OF LIEUT. A. W. WHITTLE,  
TOPOGRAPHICAL ENGINEERS, IN 1853 AND 1854.

REPORT

ON

THE TOPOGRAPHICAL FEATURES

AND

CHARACTER OF THE COUNTRY.

WASHINGTON, D. C.

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## GENERAL SKETCH OF THE ROUTE.

Our operations have been confined to a belt of country bordering upon the parallel of 35° north latitude. The conformation of this region is such as to afford some peculiar advantages for the construction of a national railroad. There are many water-courses passing through it, and valleys extend in the desired direction over a great portion of the distance between the Mississippi river and the Pacific ocean. This route would accommodate the eastern trade which centres at Vicksburg, Memphis, and St. Louis; and the railroads which are contemplated westward from those cities, through the States of Louisiana, Arkansas, and Missouri, might well converge and unite upon the Canadian.

From the eastern border of the Choctaw territory to the head of Pajarito creek, about seven hundred miles, our route is near the valley of the Canadian. Beyond, to Rio Pecos, (nearly forty miles,) it passes a ridge which extends northwardly from the Llano Estacado and divides the waters of the Mississippi from those of Rio del Norte. After crossing the Pecos, threading Cañon Blanco, and traversing the high mesa which breaks the continuity of the Rocky mountains, this line unites with the valley of Rio Galisteo, and strikes the Rio del Norte near San Felipe; or, by a shorter route, from the lagunas near the head of Cañon Blanco, proceeds by the way of San Antonio Pass to the narrows of Rio Grande, at the Pueblo of Isleta.

Having crossed the Rio del Norte, and also the Puerco, we ascend by Rio San José and the broad opening in which it takes its rise, to a low point upon the crest of the Sierra Madre; the range which divides the waters flowing towards the Gulf of Mexico from those emptying into the Pacific. From this summit, the valley of Rio Puerco of the west leads to Colorado Chiquito, (Flax river,) down which we proceed to the great bend towards the northwest. Then, by a pass south of the San Francisco mountains, we enter a well-wooded region where springs feed the head branches of Rio Verde. Continuing westward, we cross various small rivulets, and, edging along the banks of Pueblo creek, ascend to Aztec Pass. Thence to the Mojave villages two routes are noticed: one, following the valleys of Williams' river\* and Rio Colorado; the other, a shorter line in nearly a direct course westward from Aztec Pass, via White Cliff creek and a gap which separates the Cerbat range from the Blue Ridge or Hamook-habi mountains, to the Colorado above the cañon of "The Needles," near Camp 132. Leaving Rio Colorado at the Mojave villages, we pass the Paiute mountain, with steep but regular slopes, to Soda Lake, and a few miles beyond, upon the flowing waters of Mojave river, unite with the survey of Lieutenant Williamson. As that officer is now understood to have been successful in his explorations through one of the Tulare passes to San Francisco, we need but refer to his report for a description of the remainder of this route to the Pacific.

The line will now be divided into sections, and the topographical features of the country given somewhat in detail.

\* Heretofore called "Bill Williams' Fork." The Mojave or Cuchan name of this stream is "Hawil-hamook," meaning third river.

## SECTION V.

*From Rio del Norte to Flax\* River, 237.5 miles.*

Bridging the river at San Felipe or at Isleta would not be a difficult operation. Few of the principal railroads in the eastern States are without structures of equal magnitude. From the point selected, a gentle curve toward the south would enable the engineer to ascend the steep slope of the high table-land which divides the Del Norte from Rio Puerco. Thence, passing to the latter stream, he would reach its junction with the valley of Rio San José, which extends westwardly to Campbell's Pass of the Sierra Madre. To this point the grades would be light, the maximum being 53 feet per mile. Excellent spruce and pine timber is plentiful upon the slopes of Sierra Madre, and may be easily obtained. Material for masonry is also sufficiently abundant.

By the term "Sierra Madre" is meant—according to Mr. Gallatin†—"that ridge which separates the waters that fall into the Atlantic from the rivers which empty into the Pacific ocean, without any regard to its elevation." Near the sources of Rio Gila it is a lofty range. Below the parallel of 32° 30' the chain is broken, and divided into a series of minor ridges, having crests, more or less prominent, extending in the same general north and south direction. Near latitude 32° this system is extended to about 3° in width, and the low swelling ridges form a succession of basins, without any surface outlet for their scanty supply of waters. Here rains are absorbed by the sandy soil, or are evaporated from the mineralized surface of some shallow lake. The most favorable passage of the Sierra Madre range that can be found north of the head-waters of Rio Gila, is probably at Campbell's Pass. This, although more elevated than those of the Mesilla country, possesses but one crest intervening between the waters of the Atlantic from those of the Pacific. It is a wide gap, separating the ridge known as the Zuñi mountain from the Sierra de San Juan; upon the east the waters of Agua Azul flow through the open valley of San José, and a rill from the spring of Ojo del Oso courses along the gentle declivity which forms the Rio Puerco of the west. The great advantages of this pass of the Sierra Madre consist in its single summit; in the easy grades by which it may be approached east and west; in the convenient positions of springs and streams; and in its close proximity to forests of good timber.

Westward from this point we have the valley of Rio Puerco of the west, extending in a general west-southwest course for 121 miles, to its junction with Flax river; the average grade being about thirteen feet per mile. After leaving the slopes of the Sierra Madre the sylvia consist of cedars upon the prairies and a few cotton-woods upon the banks of the streams; the pine forests of the Zuñi mountains contain an ample supply of timber for this section.

The main survey crossed the Sierra Madre by the pass of the Camino del Obispo, and thence traversed the valley of Zuñi. The following notes relate more particularly to that line.

The valley of Rio Grande from Albuquerque to Isleta, fourteen miles, is wide and fertile. It contains several villages and large *haciendas*, surrounded with well-cultivated fields, which are irrigated by numerous *acequias* that traverse the bottom-lands. Upon the west it is bounded

\* Flax river is the translation of "Rio del Lino," the first Spanish name given to the stream lately known as the Colorado Chiquito. As there are already within our territory many rivers named Colorado, it would seem desirable to withdraw this from the list.

† See letter of Hon. Albert Gallatin, in Major Emory's report, Ex. Doc. No. 41, 30th Congress, 1st session.

by the bluff edge of the mesa, 700 feet in height, that divides it from the valley of Rio Puerco. The best point for ascending it is below Isleta. Between Albuquerque and Atrisco the river is wide, shallow, and usually fordable—measuring 650 yards in width, from bank to bank, and two to three feet in depth, in two channels which enclose a shifting sand-bar. The banks are flooded during freshets. The crossing at Isleta is much more favorable for the construction of a bridge. Spurs, from twenty to twenty-five feet in height, from each side come down to the water's edge, and the width of the river between is about 800 feet. The bluff of the Puerco mesa here makes a salient point, but below forms a re-entering angle back of Las Lunas, where a wide and open ravine leads by a gentle ascent near to the top. The valley of Rio Grande, opposite the village, is wide, and upon both sides of the river are groves of timber.

The ascent from Isleta commences at station 1, and follows the edge of the mesa slope. Considerable lava and volcanic cones were found in the vicinity of the trail. The soil of the lower portion of the hill is sandy. The upper stratum of the mesa is a rocky cliff, nearly unbroken upon our right until we reach the water-course at F. Station 4 is upon the top of the mesa. Thence for several miles the surface is nearly level, and beyond, we gradually descend by a wide ravine to the Puerco valley, near the mouth of Rio San José.

From Isleta, with light cutting and filling across the gentle spurs, and by keeping higher upon the slope to the right of the trail, the maximum grade to station 3 would be 52.5 feet per mile. From station 3 to station 4, with a maximum filling of 30 feet, the grade is 76 feet. From 4 to 5, the location is on the top of the mesa nearly level. From station 5 to Camp 62, the grade is from 46 to 56 feet per mile.

At Camp 62, the bed of Rio Puerco is 18 feet below the alluvial soil of the valley. It can be bridged with a span of 100 feet. The tongue of land included between Rio San José and the Puerco is formed by a ridge of hills, with flat tops, covered with cedar trees. The trail crossed this ridge a few miles north of the valley of San José.

The ascent to the hills is quite steep. From station 1 to station A, the soil is composed of clay and sand. Twenty-five yards to the left of station A is a hill containing coal. Station 2 is between two hills, 20 yards distant and 20 feet in height, composed of sandstone. At station 3 commences an ascent of 200 feet in two thirds of a mile, station 8 being upon the summit. Station 12 is in an arroyo 50 feet below the general surface. To the left of station 16, one mile from the trail, are hills covered with cedar trees. From station 15 to 16, the ground has a general slope towards the San José valley upon the left. To the right of the trail there is a range of hills with rocky sides. At station 16 they come within 20 yards of the trail, and are 85 feet high; somewhat further on, they are composed of red and white sandstone. The valley extends to the left about a mile, and is bounded by a mountainous range covered with cedar-trees. About station 17 the soil is sandy, with but little grass. One mile to the right of the trail, from station 17 to 19, there is a range of hills 120 feet high. The base is formed of a stratum of red sandstone. Thence we follow the wide valley of Rio San José, in which is the deserted valley of Rito, to Camp 63, where steep, rocky banks approach the river, forming a cañon. On the right, the red sandstone bluff is 300 feet high. The stream here, usually called Rio Rito, is a good-sized brook; the water is slightly impregnated with salts.

The route from Rio Puerco to Camp 63 should follow the valley of Rio San José, which affords a light grade, 17.5 feet per mile being the natural inclination of the stream. The trail is less favorable; though in the vicinity of it, with considerable cutting and filling, a line may be traced whose maximum grade would be 70 feet per mile for a distance of two and a quarter miles.

Between Camp 63 and the Pueblo of Laguna, the San José river is deflected towards the north by a spur of hills, at the point of which a narrow cañon is formed. The wagon trail is across the hills; though with some labor in rock cutting, the banks of the stream would doubtless afford a better location for a railroad. From Camp 63, the trail follows the edge of the stream to station 4, where it turns into a ravine upon the left, and ascends the high lands. From station 7 to 10, the rise is 79 feet in a third of a mile. Thence, passing the crest, the descent is

moderately gradual to station 11, in the valley of La Laguna. From station 11 to 12, the trail crosses the river. Above this point there is no obstruction in the wide valley of San José. The road, however, passes over the rocky eminence, about 70 feet in height, upon which stands the Pueblo of Laguna. Thence it follows near the edge of the bluffs, which upon the north bound the cultivated basin of La Laguna, to a branch of the valley leading to Covero.

The direct route from La Laguna to Camp 65 is through the valley of Rio San José, leaving Covero about two miles to the north. That by the trail, however, may be followed with nearly equal facility. It leads from Camp 64, through the town of Covero, to a broad plain which slopes gently from San Mateo to Rio San José. Station 7 is upon the edge of that stream, where the banks are steep, and the channel 20 feet in width. There are cedars upon the hillslopes, but no timber in the valley. Thence the trail to Camp 65 follows the narrow belt of alluvial soil that borders the river; the bluff banks enclosing it increasing from 50 to 150 feet in height. About two miles north from station 10, is the foot of a bluff which bounds the mesa surrounding the volcanic peak of San Mateo. It is about 1,000 feet in height; and, at station 15, approaches to within 300 yards of the river. At station 17 the valley is one mile in width, and thence to Camp 65 it is covered with luxuriant grass. The hills upon both sides are covered with cedar and pine timber. The river flows beside, and sometimes beneath, a broken course of lava which threads the valley. The grades are easy from La Laguna to this point.

Near Camp 65 the trail crosses the river and ascends the valley with nearly a uniform grade, via Ojo del Gallo, Agua Azul, and other head springs of Rio San José, to the wide opening at Campbell's Pass, 8,952 feet above the level of the sea. Upon the left are the Zuñi mountains, covered with forests containing several varieties of excellent pine timber. From the summit westward for about three miles, to Ojo del Oso, the head springs of Rio Puerco of the west, the surface is somewhat broken, requiring a moderate amount of cutting to attain a uniform grade of 50 feet per mile. Thence the Rio Puerco of the west leads through a wide valley toward the west-southwest, crossing the trail from Fort Defiance about twenty-five miles north-northwest of Zuñi, and coursing onward to Flax river, with which it unites near the mouth of Lithodendron creek.

The wagon route through the Obispo Pass and along the Zuñi river struck the Puerco of the west near the Navajo springs, at Camp 74. The region traversed is fertile, but unfavorable for a railroad, on account of the high altitude at which the Sierra Madre was crossed, and the necessity of a tunnel at that place. The grades through Campbell's Pass and along Rio Puerco of the west are highly favorable; but the river, though at all times containing large pools of water, is not a constantly flowing stream, and its banks are destitute of timber. Cedar forests, however, cover the mesas in the vicinity. Near its mouth, the Puerco, like Lithodendron and other creeks in that region, cuts through the gravelly mesa, and forms deep ravines which would require bridging. Quarries of sandstone, fit for masonry, may be found in the vicinity of the valley of Flax river.

## SECTION VI.

*From Flax River to Rio Colorado, 307.7 miles.*

It is much to be regretted that a greater length of time could not have been devoted to the examination of the region embraced in this section. It is full of interest, and probably no other portion of our territory would so richly recompense the cost and labor of a minute exploration. The region referred to is mainly included between the Gila and Colorado rivers, and their principal tributaries, Rio Verde and Flax river. The latter, having its sources in the Mogoyon and Zuñi regions, flows west and northwest to the Colorado, with which it is supposed to unite near the head of the celebrated Great Cañon. Thence, the Colorado is said to course westward, through a fissure 1,500 feet below the surface of the vast plain that borders it, to the mouth of Rio Virgen; there it turns south, and moves onward to the junction of Pío Gila. Rio Verde takes its rise near the San Francisco mountains, and, flowing south through fertile valleys, joins the Salinas and unites with Rio Gila near the Coco Maricopa villages. The Gila forms the southern boundary of the area under consideration, which our line of survey intersects. It is traversed by several mountain chains of greater or less extent—of which the Hamook-hábi (Blue Ridge), Cerbat, Aquarius, Aztec, Black Forest, and Mogollon ranges are the principal—and dotted with many conical hills of volcanic origin. Between them are springs, streams, and valleys of considerable fertility.

The northern portion of this area is believed to be an elevated table-land of the new-red sandstone formation; with strata slightly dipping towards the north-northeast, forming a region nearly as barren and waterless, upon the surface, as the celebrated Llano Estacado. Captain Sitgreaves traversed it in 1852, and from Camp 21 to Camp 26, a distance of 75 or 80 miles, no water was found. Near the parallel of  $35^{\circ} 15'$  the strata are broken; and south of that line the upper portions are swept away, exposing "magnesian limestone, sandstone of the coal measures, and the carboniferous limestone." Still farther south, "and especially at Pueblo creek, beds of old-red sandstone are seen below the lower carboniferous, and in contact with the gneiss and granite, similar to the old-red of the Catskill mountains."\* Extending across this country, in a direction northeast and southwest, there is a series of volcanic cones indicating an axis of igneous eruptions. The San Francisco peaks, which are 5,000 feet above the base of the mountain, and 12,000 feet above the sea, appear to mark the point of greatest activity. Thence the line of cones can be traced eastwardly across Flax river towards the Moqui country, and southwest so as to include Bill Williams' mountain, Mount Hope, in the Aztec range, and Mount Ives and Artillery Peak, upon Williams' river. Whatever may be the cause, the fact is evident that a large portion of the region south of the parallel of  $35^{\circ} 15'$  is well watered and fertile; while that north of it is the reverse. Ruins of ancient pueblos and evidences of former cultivation are abundant throughout the valleys leading towards the Gila. The mountains and hills are covered with timber, the plains are variegated with patches of woodland and pasture, and the borders of the streams contain belts of arable soil. This country is capable of sustaining a considerable pastoral and agricultural population; and, probably, the mines of silver and gold reported by the Spaniards and Indians as existing in the San Francisco and other mountains in the vicinity, and of which we saw indications, will add inducements to its settlement.

West of the Aztec range the character of the country is considerably modified. The streams have generally a southwest course until they break through the beds of trap, lying upon the

\* See the preliminary report of Jules Marcou, geologist to the expedition

eastern slope of the Aquarius mountains, and join the main valley of Williams' river. North of White Cliff creek there are long, swelling slopes, peculiar to a granitic region, with two distinct ranges of mountains between Cactus Pass and Rio Colorado. These ranges extend nearly in a north and south direction, with broad depressions between them. The eastern terminates, or is broken, near the parallel of  $35^{\circ}$ , leaving between it and the northern point of the Cerbat range a wide opening. The western range, called Blue Ridge, or *Hamook-häbi*,\* which borders the left bank of the Colorado, extends somewhat farther south; but gradually diminishes in height, and, near the latitude of the Mojave villages, is lost in an extensive prairie. Upon the east this prairie is bounded by the Cerbat range; and upon the south by numerous parallel chains of metamorphic mountains, through which Williams' river breaks in its course to the Colorado.

At the southeast point of the great bend of Williams' river is the junction of Rio Santa Maria, which appears to take its rise near a low depression in the Aztec range between Sierra Prieta and Mount Hope. It evidently drains a wide extent of country, the character of which is not known. Near its mouth it has a strip of valley with alluvial soil of apparent fertility. The sylvia upon its banks are mezquites, mingled with cotton-wood trees.

From the Aztec range to the Aquarius mountains, the hills are covered with pine and cedar trees; and the plains, which are mainly formed by immense beds of trap, are clothed with a carpet of nutritious gramina. Most of the numerous rivulets which traverse this region, south of the latitude of Aztec Pass, form narrow cañons through the igneous rocks, and possess little soil capable of cultivation. Enclosed between the Aquarius and Cerbat ranges is the bed of Williams' river, which flows nearly south until it enters short cañons among metamorphic hills of the Cerbat range; it then turns westward, unites with the Santa Maria, and forces its way to the Colorado. The bottom-lands of the valley will average from half a mile to a mile in width, and the surface consists of alternate patches of sand and fertile soil. Groves of mezquite and cotton-wood, with dense thickets of willows, exist upon its banks, giving to this stream some of the characteristics belonging to the Gila. The hills that enclose it are generally barren of all useful vegetation, though diversified with numerous varieties of beautiful cactaceæ, rendering the scenery novel and picturesque.

From an examination of the observations made at numerous points of the survey, it now appears evident that gently sloping prairies extend continuously from the mouth of White Cliff creek around the northern extremity of the Cerbat range; and thence, sweeping slightly south for the purpose of avoiding the Blue Ridge, to the Mojave crossing of Rio Colorado. The distance for a railroad by that line would be about 70 miles. Grades of about 92 feet per mile could probably be obtained, with little expense for excavation or embankment. There is neither timber nor fuel in the vicinity; both would be brought from the Aztec and Aquarius mountains. Water is scarce; the Indians informed us of two springs only upon the route, which would make the distance from water to water about twenty-five miles. I do not know whether the substrata are such as to make it probable that water could be obtained at proper points by artesian borings; but a supply could doubtless be preserved by judiciously constructed tanks.

From our entrance to the valley of Rio Colorado Chiquito, or Flax river, its course is slightly north of west to Camp 82, a distance of about 35 miles; and the arable soil bordering it averages from one to two miles in width. The river is about 30 feet wide, flowing between alluvial banks eight to ten feet in height. The soil is generally light and porous, like that of Rio Gila.

\* Mr. Blake has lately called my attention to the etymology of the word "Mojave." It appears to be formed of two Yuma words - hamook (three,) and häbi (mountains)—and designates the tribe of Indians which occupies a valley of the Colorado lying between three mountains. The ranges supposed to be referred to are: 1st, "The Needles," which terminates the valley upon the south, and is called *Asentic-häbi*, or first range; 2d, the heights that bound the right bank of the Colorado north of the Mojave villages, termed *Ilavic-häbi*, or second range; and, 3d, the Blue Ridge, extending along the left bank of the river, to which has been given the name of *Hamook-häbi*, or third range.

The banks of the main stream, as well as those of the numerous tributaries, are sprinkled with cotton-wood trees. Small groves of them occur at the junctions of these streams. Leroux's Fork is crossed near Camp 78. It is a rivulet of clear water about 20 feet wide, and densely wooded. Beyond, the valley is bordered with low, gravelly mesas, covered with a species of nutritious grass called grama, and has an elevation of about 50 feet above the river. The wagons frequently crossed spurs from them to avoid patches of soft earth in the bottoms. Between stations 3 and 4, a valley half a mile wide comes in from the northeast. At station 5, there is a branch from the north, with steep banks 10 feet in height. Between stations 5 and 6, sandstone bluffs, rising upon the right of the trail to the height of 150 feet, bound the valley, which is here one-third of a mile wide. Upon the opposite side of the river, near station 10, is the escarped edge of an elevated plain, extending south, apparently, to the Mogollon mountains. It is intersected by several tributaries. Between Camps 79 and 80, the river-bottom is in some places marshy, with willow thickets, and in others covered with a loose, pulverized soil. The south side of the valley appears to be in some places from two to two and a half miles wide. There is much marshy ground between Camps 80 and 81, which may be avoided by following the trail along the edge of the prairie slopes. Cottonwood Fork joins Flax river near station 2. The latter stream may be bridged at this place, or the line continued upon the north bank to the old Indian pueblo at Camp 82. Here the river is finely timbered with cotton-wood, and the south side of the wide valley contains traces of an ancient acequia.

At the point where the trail crosses the river, the stream is 50 feet wide, two and a half feet deep, and flows between clayey banks about 10 feet in height. A short distance below, it makes a bend and sweeps towards the north and northwest. To avoid this deflection, a reconnoissance was made in a direct line nearly west towards a low gap south of the San Francisco mountains.

Leaving the valley of Flax river a few miles below Camp 82, a low and narrow ridge was crossed, and a basin-like valley was entered, which, although containing no well defined stream, was said to be the outlet of Dry Fork. Having traversed this for about five miles, a gradual and almost imperceptible ascent led to a high prairie, somewhat cut up by gentle valleys, and dotted with isolated hills of sandstone, from 15 to 30 feet in height. Twenty-six miles from Camp 82 is the crossing of Cañon Diablo, which flows north in a chasm from 100 to 150 feet deep, and about 100 yards wide, cleft in a horizontal stratum of magnesian limestone. Thence to station 4, between Camps 89 and 90, the general surface of the intermediate country is a plain, sloping towards the east with an inclination of 40 feet per mile. It is, however, traversed by several ravines, occasionally forming small cañons; but they interpose no serious obstacle to the construction of a railway across this section. There is water in Cañon Diablo, and at the Conino caves, near this line; probably it could be found at other intermediate points. Cedar trees are scattered along the trail between Dry Fork and Cañon Diablo. Dense thickets commence a short distance further west; and, upon reaching the vicinity of the Conino caves, they give place to forests of magnificent pines.

From the base of the San Francisco peaks, many wide valleys, bounded by heavily timbered hills, extend towards the branches of Cañon Diablo and Flax river. Station 4 is upon the northern edge of one of the former, called Pine valley, which has a breadth of about five or six miles. The trail ascends its smooth, grassy slope. At station 6 the valley is several miles wide; at station 9, it unites with a broad, open prairie, bordered with pine forests, and extending towards the northwest to the foot of the steep mountain slopes. Continuing up this valley towards the southwest, at station D we reach the summit of a low ridge between the San Francisco mountains and a long spur from the Sierra Mogollon, which divides the waters of the Colorado Chiquito from Rio Verde. The ascent to this point is remarkably uniform; and the deep depression which here exists between the mountains is about a mile in width, and so gentle in its declivities as to render it difficult to define the exact position of the dividing crest. Superb forests cover the slopes of the mountains upon each side. The maximum grade through this

pass—according to the profile—is 85 feet per mile; and an excavation would be required at the summit. Thence to Camp 90, the descent would not be difficult with moderate grades.

From Camp 90 to station 5, the line continues upon the edge of the pine forest overlooking the immense valley of Rio Verde. This stream heads in various ravines formed by spurs from the San Francisco mountains. The southeastern terminus of this range, or rather mass of mountains, is a huge pile of granite, rising abruptly upon the right of the trail to the height of about 2,500 feet. To the northwest, several volcanic peaks appear, elevated 5,000 feet above the base. Crossing the low spur upon which station 7 is situated, we enter another branch of the valley, and at station 13 reach the springs of San Francisco. Water is abundant here, and it flows in a small stream southward to the Rio Verde. From these springs we pass a slight ascent, and enter a dry cañon, the narrowest part of which (about 100 feet) was plentifully strewn with boulders broken from the cliffs. From this point the trail ascended the bank, about 200 feet in height, and, having crossed an undulating surface, re-entered the valley at station 9. Thence to Camp 91 there is a broad valley the whole way, and at the head of it is Leroux's spring, where a stream of clear water gushes from the hill-side. Its temperature, December 29, at sunrise, was 48.4° Fahrenheit; that of the atmosphere at the same time being 37° 5. Large pine and spruce trees grow in the ravines and upon the sides of the mountains; and extensive forests of different varieties of good timber cover the vast plains and valleys that slope toward the south. With regard to the construction of a railroad from Camp 90 to Camp 91, no difficulties were presented to the eye, except for a short distance through the cañon referred to. The reduction of the notes of survey, however, leads to conclusions less satisfactory than had been anticipated; and, unless some error has crept into the work, the maximum grade will exceed 90 feet per mile, and the labor of graduation will be great. To avoid these objections a more southerly course across branches of Rio Verde has been recommended.

Leaving Leroux's spring, and the fertile basin which it irrigates, the trail crosses a slight ridge\* north of Triangulation hill, traverses a forest of yellow pines and long, grassy plains to New Year's spring, at Camp 94. A secondary range extends towards the west, from the San Francisco peaks, and, two or three miles distant from the trail upon the right, contains several peaks from 2,000 to 2,500 feet above the plains at their southern bases.

Nearly south-southwest from New Year's spring is Bill Williams' mountain, about 10 miles distant, whose peaks are above 3,000 feet high. The intermediate country has a generally level surface, divided into woodland and prairie. The hill-slopes are covered with pine timber.

One mile west from New Year's spring there is a hill about 200 feet high, from the top of which is obtained an extensive view of the surrounding country. Towards the north and north-northwest appears an elevated plain, looking bleak, waterless and barren. It is dotted with conical hills of black volcanic rock. In a west-northwest direction, a broad open valley, dark with the foliage of cedar forests, extends to the mountains of La Laja, and for some distance is bounded upon the southwest by a low range of hills covered with trees excellent for timber. Towards the south-southwest lies the volcanic pile of mountains called "Bill Williams'," west of which is a succession of valleys and plains extending about 30 miles from New Year's spring to a conspicuous peak known as Picacho. This is the southern terminus of the range of La Laja; and at its base Partridge creek, which drains the intermediate country, empties into *Val de China*. The triangular space included between New Year's spring, Bill Williams' mountain, and Picacho, has the general appearance of a vast plain sloping gently to the southwest; examined more minutely, it is dotted with small hills and traversed by valleys, which in a few places are contracted, and enclosed by low walls forming cañons. There is good pine timber in

\*A reduction of the reading of the barometer at noon upon the summit of this ridge makes its altitude 294 feet above Leroux's spring. Mr. Campbell agrees with me in the opinion that it is too great. This appears to be one of the errors which will be found referred to in the subsequent "Remarks upon the profile." It is consequent to the application of the formula for correction due to mid-day air temperatures. The effect is, as there stated, to give a roughness to the profile, and heavier grades than the surface of the country requires.

the vicinity of New Year's spring, and also in the region of Bill Williams' mountain. East of Val de China lies an extensive tract covered with large cedars and piñons, forming the so called Black Forest.

It may be seen from the profile, that, by the trail from the San Francisco springs to Picacho, the route is not impracticable for a railroad. The conformation of the country south of that line, however, is such as to lead to the belief that, by crossing the head branches of Rio Verde south of Bill Williams' mountain, traversing the Black Forest, and entering Val de China near the mouth of Pueblo creek, we would avoid the ascent above the San Francisco springs, entirely dispense with the most elevated summit upon the route, and shorten the distance to Aztec Pass without increasing the grades or expense per mile for graduation. Many questions regarding similar deviations from the line are to be determined by more elaborate surveys.

A semi-circular range of hills extends from the San Francisco peaks to Bill Williams' mountain, forming the northern and eastern boundary of the flat prairie and forest basin, which has been described. Near New Year's spring there is a wide gap in it, where the ridge is almost inappreciable. From this point a low spur extends west and west-northwest to the mountains of La Laja; dividing the water courses which drain northwest, through Park valley, from those that flow, by various branches of Partridge creek, into Val de China. From the examinations made, it was found easy to pass down the southern slope of this ridge into the valley of an eastern branch of Partridge creek. By some mistake, however, attributed to the intricacies of the numerous ravines, and the thickets of trees that cover much of this region, the train and the main survey followed, for a considerable distance, the northern base of the ridge, and beyond Camp 95 crossed over to Partridge creek. The more minute topography is, therefore, upon this line.

New Year's spring, at Camp 94, is at the head of one of the branches of Park valley. It is surrounded by a grove of pine trees, from 125 to 150 feet in height. Leaving the spring, we ascend the low prairie ridge and take a westerly course over a surface that, at a distance, appears level; but is found to be considerably broken by ravines, some of them from 30 to 50 feet in depth. The first contained pools of water. Station 1 is in Park valley, which, covered with cedar trees, extends like a broad plain towards the northwest, with the view uninterrupted almost to the horizon. Savedra made an exploration across this valley, and was absent three days without finding water. Again rising to the prairie at station B, we were about half a mile from the most northerly peak of Bill Williams' mountain, which is about 500 feet in height. To our right, between stations 3 and 4, there is a valley; and from 4 to 7 the trail is parallel to it. Between stations 8 and 9 we crossed a cañon, and at station 10 entered another; both of which incline to the right. Passing onward to Lava creek, we found a magnificent pool of water, and encamped. The soil of the prairies, though covered with excellent grama, is somewhat sandy, and overlies beds of lava or trap. The rock is exposed upon the sides of the cañons. Even the valleys have little depth of soil, and are uncultivable. Pine trees cover the hills and extend along the valleys. The grade for a road need not exceed 55 feet per mile. The ravines would be difficult to cross, but by keeping more to the left, most of them could be headed.

From Camp 95 to station 4, the trail descends to a broad cañon, about one-fourth of a mile wide at top, and the banks 75 feet in height. Near stations 7 and 8 are large piles of naked lava. The pines have now given place to cedars, which cover the slopes in every direction. Passing a slight elevation, we entered another valley, which, as we advanced, grew narrow, and between stations 8 and 9 formed a rocky ravine. We ascended the side slopes 135 feet to station B, which is upon the crest of a high ridge covered with cedar and piñon trees. It is composed of sandstone and carboniferous limestone, and extends far towards the right with a regular slope. About three or four miles beyond, there is a similar and parallel range of hills; and, between, lies a wide valley, densely wooded, and called—perhaps improperly, for we found no water in it—Cedar creek. From station B the descent for about 200 feet was at an inclination of nearly 45°; thence to station 1A, two miles, 200 feet; and from that point, one mile and

a third, to Camp 96, in the bottom of the valley, 160 feet. This ridge would be impracticable for a railroad, except for the smoothness, regularity, and extent of its western slope. From an examination of the ground, it would appear practicable to cut through the crest at the gorge referred to, and construct a road upon the side slope, with a grade of about 75 feet per mile. This would enable us to strike the trail at station 14, between Camps 96 and 97.

From Camp 96 we followed the valley, which between stations 1 and 2 is contracted to the width of 150 yards, with banks from 20 to 30 feet in height. Beyond, the slopes upon the left are gentle; and at station 5 a wide branch of the valley comes in from the south. Three miles to the right of station A is the continuation of the bluffs, crossed at station B, between Camps 95 and 96; and they continue far towards the west-northwest. The valley between is dotted with knolls and sprinkled with cedar thickets. The surface is smooth and covered with grass. A quarter of a mile to the right of station 13 there is a hill 200 feet high. The slopes to the right are very gentle; the surface is prairie, with few trees. Upon the hill-sides, to the right of stations 14 and 15, much red sandstone appears. Here we passed a low dividing ridge, and entered the valley of Partridge creek—high hills continuing upon the right of the trail. Beyond, the valley becomes narrow, and at length enters a cañon of Partridge creek, with high bluff banks, which are covered with cedar trees. The trail followed the undulating slopes upon its borders to Camp 97, situated within a rocky glen, where the creek contained large pools of water. The geological outcrops are of the lower carboniferous formation. The country passed over is rough, but the general slopes are favorable for a roadway. From station 14 to Camp 97 the maximum grade may amount to 80 or 90 feet per mile.

From Camp 97 to Camp 98 the route lies near the cañon of Partridge creek. Its steep banks are from 50 to 80 feet in height, varying from one to three hundred yards in width. The top of the bluffs, though broken and rough, are upon a level with the general surface of the country, and, for a road, the labor of graduation would be less at some distance from the creek. The stream is not flowing, but it contains numerous pools of water. Grass and trees are abundant upon the trail. There is but little arable soil in the vicinity.

From Camp 98 to station 5, the trail follows the bed of the cañon. At that point the banks recede, leaving a good-sized valley between. The stream, however, makes a large bend toward the southeast; and, to avoid it, the line of survey took a direct course southwest across the nearly level prairie toward Picacho. Between stations 9 and 10 is a dry arroyo leading to Partridge creek. The ridge of Black Forest appears about fifteen miles to the left. Another chain of hills lies upon the right, about ten miles distant. From station 10 to 14 the country is level, producing a few scattered cedar trees; thence to Camp 99, the trail crossed a rolling prairie, intersected by a number of deep ravines, in which water was found. About three miles to the northwest is Picacho, with a gravelly spur extending to the vicinity of camp, and forming the southern terminus of the range of La Laja; the Black Forest range, from the south-southeast, ends about two miles southeast from the same point, leaving between the two ranges an opening through which Partridge creek flows into the great Val de China. The bed of this valley is about 200 feet below the general surface of the prairie, which borders Partridge creek, and ends in a bluff below Camp 99. Camp 100 is situated at the foot of it, about one mile distant from, and 188 feet below, Camp 99. By following Partridge creek from Camp 98 to its entrance to Val de China, the grades would be light. It would, probably, be equally practicable to construct a road along the trail, from station 5 to station 15—between Camps 98 and 99—and there entering a ravine, follow it to the confluence with Val de China, near Camp 100. The gradients would be favorable, except upon the latter portion, where they might amount to eighty feet per mile. The direct route from New Year's spring, referred to in the general description of this region, would take the northeast branch of Partridge creek, and unite with the survey near Camp 100.

Between Camps 100 and 101, a distance of seven and a half miles, the trail passes across the rich bottom-lands of Val de China, in a southwest course, nearly perpendicular to the general direction of the valley at this point. The country is smooth enough for the laying of tracks

for a road upon the surface. There are a few water-worn channels, which would be crossed by culverts or short bridges.

From Camp 101 the course of the trail is south-southwest, toward Mount Hope. Upon the right is the northern part of the Aztec range of mountains, and from the base of its steep sides low spurs of hills extend westwardly, gradually sloping to the edge of Val de China. Through these hills, which are covered with cedar trees, the trail ascends the gentle slope of a small ravine to its head near station 5. Thence it passes a low ridge and enters a small valley, with rich alluvial soil, through which flows a pretty rivulet called Turkey creek. Amidst a grove of oak and walnut timber is Camp 102. From Camp 102 to Camp 103 another spur of hills is crossed, which separates Turkey creek from Pueblo creek. The latter stream heads at Aztec Pass and flows easterly through a wide and deep ravine, dividing this range of mountains into two portions; the northern being horizontally stratified, the southern disturbed and changed by subterranean heat. From the foot of the cliffs upon the north to the bed of the rivulet, the slopes are regular, affording a side location for a railway, with favorable grades around the southeastern and southern declivities, from the ridge near Turkey creek to Aztec Pass; thus avoiding the descent to Camp 103 upon Pueblo creek. There is considerable arable soil upon this stream, and in the vicinity a variety of sylvia. The mountains are covered with pine timber; the living streams are bordered with oak, cotton-wood, walnut, or ash, and the hills yield a dense growth of cedars.

Aztec Pass is between Camps 104 and 105. It is upon the top of a low granitic spur, which



View of Aztec Pass from the Indian ruins, looking south.

seems to connect the northern with the southern portion of the Aztec range. At its junction with the steep slopes of the southern peaks, two water-courses are formed. The eastern falls down a steep ravine, half a mile to the foot of the hill, and then, joined by a ravine from the

north, forms the head of Pueblo creek. The second follows the gentle slope of a wide and smooth valley towards the west-northwest, and becomes tributary to Williams' river.

The accompanying sketch, taken from the ancient ruins that crown a height upon the north, overlooking the pass, represents the summit of the dividing ridge and the prolongation of the Aztec range towards the south. In the distance, upon the left, is seen the top of Mount Hope, and the Gemini mountain is shown upon the right. From the latter extends a sloping plain to the wide valley in which Williams' river takes its rise.

The difficulty in constructing a railroad through this pass consists in the high embankment that would be required to cross the northerly ravine above referred to. With a cut, about 40 feet deep at the summit, the excavation and embankment would be nearly equal, and the gradients probably would not exceed 50 feet per mile. Having accomplished the passage of the summit, the descent would be easy down the wide valley through which the trail follows, to Camp 105. Below, upon the banks of the same rivulet, Camp 106 is situated. A small stream threads the valley and is occasionally lost beneath the surface. But few trees line its banks, though pines abound in ravines among the mountains, and cedars are plenty upon the hill-slopes and upon the plains adjoining.

From Camp 106, the trail follows the valley, in which there are a few small cañons cut through beds of lava. The soil is a sandy loam, producing good grass. Two miles distant upon the left, there is a ridge of hills bordering the valley. Station 3 is in the bed of a ravine containing water. From station 3 to station 4, the valley is several miles wide. The slopes of the hills upon the right are regular; while, upon the left, the country is rocky and broken. A low ridge, which, extending from the Gemini mountains, turns the valley towards the north, was crossed at station 7. Thence, passing a gently undulating prairie, sprinkled with occasional thickets of cedars, we struck the stream again at Camp 107, where it has high bluff banks. A short distance below, a chasm is formed; width about 80 feet, and height of rocky sides from 60 to 100 feet. There is water in the bed of the stream, and cedar trees upon the banks. The railroad line from Camp 106 would follow the valley of the stream, making a bend towards the north, and thus avoid crossing the cañon.

From Camp 107 to station A, the ascent is not difficult. Thence, attempting to descend along the bank of the stream, a deep ravine was crossed. One mile to the right of the trail, there extends a ridge of hills belonging to the Aquarius mountains. The general surface of the country is an undulating prairie; the soil containing much clay and loam. The prevailing rocks are granite and trap, which are so much cut up into chasms as to make the passage with wagons difficult. Hence the train returned; and Camp 108 was formed at station A, in the immediate vicinity of Camp 107. A reconnoitring party, however, pursued the course of the stream some miles further, and then passed northerly over the slopes of the Aquarius range, to White Cliff creek, which was followed to its junction with Big Sandy.

From Camp 108 to station A, the surface is somewhat broken. A small stream crosses the trail between stations 1 and 2, and another between stations 5 and 6; both evidently branches of White Cliff creek. From station 3 to station 7, the surface continues undulating; although the general slope is quite uniform, and from a slight eminence appears level. From station 7 to E, between stations 10 and 11, the trail passes over low ridges which divide ravines that have a southerly direction. Upon the right, three miles distant, there is a range of hills 400 feet high. To the left of station 9 there is a large valley, supposed to contain the main branch of White Cliff creek; and from station E to Camp 109 the ground is furrowed by various ravines, apparently tributaries to that stream. North of camp are rocky hills, covered with cedars. There is a chain of highlands also upon the left. The profile, from Camp 108, is projected south of the trail, along the valley noticed above.

The rivulet is rocky in the vicinity of Camp 109. The trail toward the west-northwest crosses several small valleys which extend southwest among small ridges, peaks, and mesas. From station 2 to station 3 the surface is level. Near station 4 the dry bed of a stream

is crossed. From camp to station A, between stations 6 and 7, the ascent is nearly continuous. There is a steep descent into a cañon from station 8 to station 9; and the trail from stations 9 to 15 is in the dry bed of a tributary to White Cliff creek. Passing into another branch at station 16, the trail then ascends its valley to Camp 110, near Cactus Pass. There is water in this branch of the creek, and cedar trees are still abundant upon all the hill-slopes in the vicinity. Cactus Pass is not practicable for the location of a railway; and it is proposed to make the profile for that line, as before stated, from Camp 108 down the valley of White Cliff creek. Measurements for that purpose were made upon a reconnoissance, and will be referred to hereafter.

Cactus Pass is formed by a deep gorge in a high range of granitic mountains. From the summit, about 300 feet above the pass, an extensive panoramic view is obtained. The Hamook-häbi, or Blue Ridge, is seen bordering the Colorado, and a lesser range intermediate. The latter terminates nearly in the latitude of this place, and, after an intervening gap, the Cerbat range is prolonged in the same southerly direction. Toward the northwest there is a vast plain, leading apparently to Yampa creek, and bounded upon the east by broken ranges of low mountains. East of the Cactus mountains may be seen the extensive broken plains already traversed—Cross mountain, 800 feet high, and the Aquarius range, 1,000 feet high, being the principal of the peaks and ranges that break the general level of its surface.

The ascent from Camp 110 to station 1, at the summit of Cactus Pass, is about 100 feet in little more than half a mile. Thence, down the first portion of the ravine, the declivity is nearly precipitous, and in one mile and three-quarters, to station 3, the descent is 830 feet. Here the valley becomes wide and sandy, and the trail keeps to the left of it, crossing a gently swelling slope that comes down from a southerly spur of the Cactus mountains. Near station 5 there are springs, in the vicinity of which the reconnoitring party bivouacked, January 28.

Station 6 is 560 feet below station 3. Thence to Camp 111, near the mouth of White Cliff creek, the descent is 350 feet more; making a total, from Cactus Pass, of 1,640 feet in a distance of eight miles. White Cliff creek is a clear and rapid stream, with a strip of fertile soil upon its banks for eight or nine miles up the valley, to the bivouac of the exploring party, January 27. Its principal tributary is about four miles below that point, and both streams are bordered by a dense growth of cotton-wood. The altitude of the bivouac, from the readings of the barometers, is 4,480 feet, or 950 feet above Camp 111; giving the descent of the stream above 100 feet per mile. But, as it contained no steep rapids, to the eye the declivity seemed much less, and possibly an error may have been made in the record of the observations. The distance from the bivouac to Camp 108, near the head of this stream, is about 8.5 miles; and the altitude of that camp being 4,814 feet, the fall of the rivulet between those points would be nearly forty feet per mile. Its valley, with the deflection indicated upon the profile from Camp 108 to Camp 111, may be considered practicable for the location of the railroad line. White Cliff creek is bounded upon the north by high gravelly slopes and mesas, which terminate the mountain spur south of Cactus Pass. It is therefore judged feasible to locate the line upon this ridge, so as to turn the southwest point of the high mountains, and avoid the descent to the bed of the lower portion of the creek. This line would strike the trail, from Camp 110 to 111, at station 9; which, being about 200 feet above the latter camp, would cause an improvement in the grade. Station 9 is in a valley leading, by a gentle ascent, to the wide prairie which has been described as seen from Cactus Pass. It is apparently nearly level to the gap north of the Cerbat range, and thence inclines, by broad slopes, to the Colorado river. From an examination of our topographical sketches and views, and a comparison with the heights of relative points, both upon our own exploration and upon that of Captain Stitgreaves, the elevation of the gap is estimated at 3,900 feet above the sea; giving for the ascent, from Camp 111, 374 feet, and an ascending grade of 11.5 feet per mile. From this summit a broad plain slopes the Colorado river, and a spur of it impinges upon that stream between the mountain ridge, called "The Needles," and the Mojave villages. The elevation of the bluff is 450 feet above

the sea, and the descent from the pass is 3,450 feet. The distance in nearly a straight line is 37.4 miles, and the grade, if uniform, as the appearance of the country seems to indicate, would be 92.4 feet per mile. The sketch No. 3, taken from the right bank of Rio Colorado, looking east, gives a view of the country here described.

The region which includes the Cactus and Aquarius mountains is well supplied with cedar trees. Westward the sharp-crested ridges appear naked, and the plains nearly destitute of foliage. Wood is scarce, even for fuel. The two Indian springs, already referred to as existing upon this route, probably indicate points where, by digging, a sufficiency of water would be found.

From White Cliff creek to the Mojave crossing of Rio Colorado, our wagon trail followed Big Sandy creek, Williams' river, and the valley of the Colorado. For a description of the topography upon this part of the route I would refer to the Itinerary. Although meagre in its details, it may suffice to give a general idea of the character of those streams.