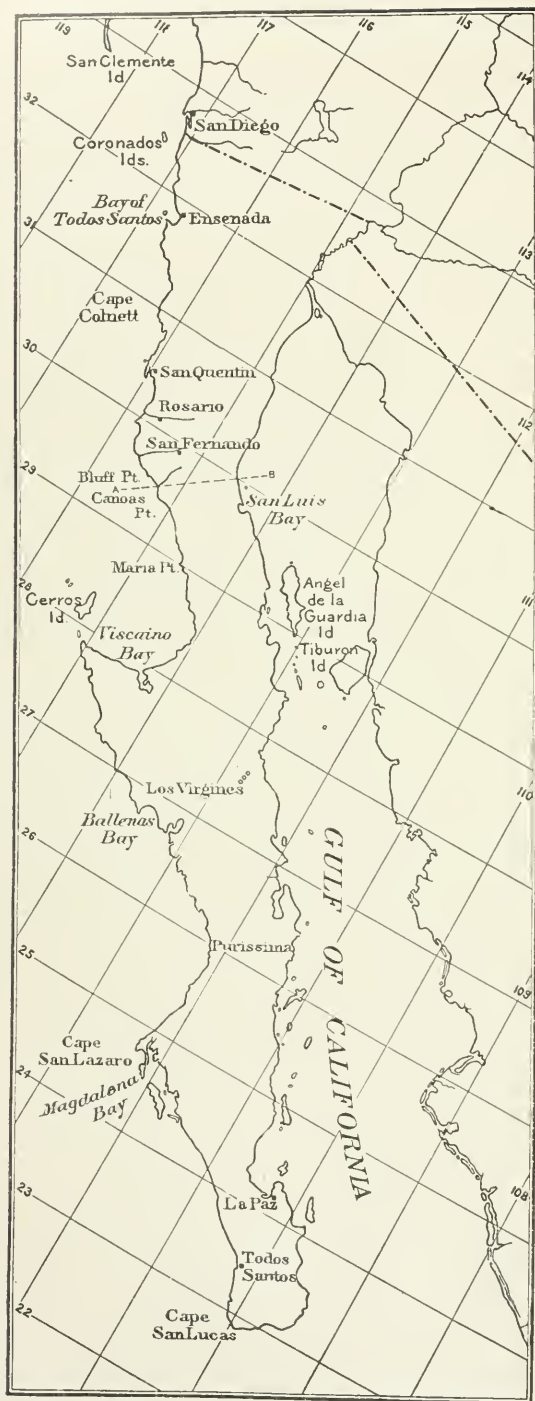

NOTES ON THE GEOLOGY AND NATURAL HISTORY OF
THE PENINSULA OF LOWER CALIFORNIA.

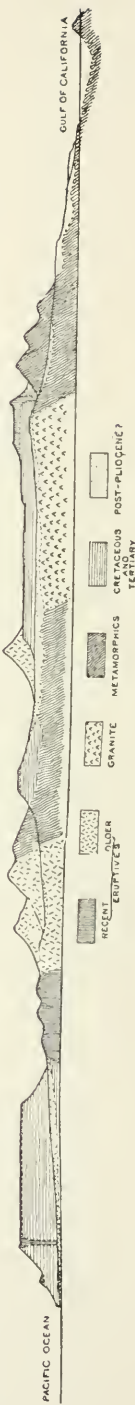
BY

GEORGE P. MERRILL,

Curator, Department of Geology, U. S. National Museum.



SECTION ON LINE A-B, LATITUDE 30°



MAP AND GENERALIZED SECTION OF LOWER CALIFORNIA.

NOTES ON THE GEOLOGY AND NATURAL HISTORY OF THE PENINSULA OF LOWER CALIFORNIA.

By GEORGE P. MERRILL,

Curator, Department of Geology, U. S. National Museum.

During the summer of 1892 the writer had occasion to pay a brief visit to the peninsula of Lower California, going by boat from San Diego to San Quentin, and thence by wagon and pack train to El Rosario and across to within a few miles of the Gulf Coast, the route lying approximately along the line of the thirtieth parallel. The trip was hurriedly made with the scanty equipments furnished by a prospector's outfit, and opportunities for detailed work were quite lacking. The resultant geological observations have already found their way into print, but a brief abstract from the original publication¹ may well be given here. The excuse for the present paper lies in the fact that the region, aside from being comparatively unknown and difficult of access, presents many features of interest from the standpoint of both naturalist and archaeologist.

Fortunately the writer carried with him a folding kodak, and though the good work done by the instrument was in some degree undone by the carelessness or ignorance of a professional photographer in San Diego, enough remains to give, with the aid of a little touching up, the views here shown. In the pages following the remarks on the physiography and geology of the region are quoted from the paper above mentioned. The itinerary is compiled from memoranda made at the time.

(1) PHYSIOGRAPHY.

"The peninsula of Baja California is a narrow strip of broken mountainous land extending roughly from 22° 50' to 32° 30' north latitude, about 775 miles long and from 35 to 70 miles in width, with a general northwest and southeast trend parallel to the larger orographic features of the Pacific Slope. Its coast outline, characterized as it is at many

¹Geological Sketch of Lower California, by S. F. Emmons and G. P. Merrill. Bull. Geol. Soc. of America, V, 1894, pp. 489-514.

points by long sweeps or reentering curves, with outlying islands and projecting points partly inclosing oval, valley-like basins, is at once suggestive of a partially submerged series of mountain chains.

“The peninsula is divided by Gabb¹ into three geographical provinces: A southern, extending from Cape St. Lucas to beyond La Paz, characterized by irregular granite mountain chains up to 5,000 feet in height, and with deep valleys containing considerable fertile arable land; an intermediate desert region, characterized by table-lands and flat-topped ridges, with a considerable extent of interior valleys, and with isolated mountain tops and ranges projecting above the general mesa level, which rarely reach an elevation of more than 3,000 to 4,000 feet. This region has no running water and springs are very scarce; a high northern portion from 5,000 to 10,000 feet above sea level forming a southern continuation of the mountain region of southern California, which has a number of running streams and large valleys susceptible of cultivation, while the higher portions contain considerable extents of pine forests.

“The limits of these three provinces are not sharply defined, but may be taken at about 200 miles in longitudinal extent for the northern, 450 miles for the intermediate desert region, and 100 miles for the southern.”

* * * * *

“While from a first glance at existing maps it might appear that the depressions of the Mohave and Colorado deserts and of the Gulf of California were the normal southern extensions of the great depression of the San Juan and Sacramento valleys, and that the Peninsula range was therefore the normal southern continuation of the coast range, there is some reason to be found in its topographical form, and still more, as will be seen later, in its geological structure, for the assumption that the peninsula more properly represents the southern extension of the Sierra Nevada uplift. On this assumption the connection between the two would be afforded by the various en echelon ranges known as San Jacinto Mountains, San Bernardino Mountains, etc., lying to the northward, while the southern extension of the Coast range proper, cut off by the reentering angle of the coast between Santa Barbara and Los Angeles, would be represented by the chain of islands, Santa Catalina, San Clemente, etc., generally known as the Channel Islands, lying off the coast between Los Angeles and San Diego.

“To the south of San Diego the mountains come down to the sea and the mesa disappears, being only represented by an occasional patch of later beds which have escaped erosion, as at Sausal and Todos Santos, 60 miles south of the boundary. At Cape Colnett, in latitude 31°, a strip of mesa forms the immediate coast and widens southward toward San Quentin, in latitude 30° 30', which is assumed to be about the limit of the northern or mountainous province. From San Quentin south-

¹See article on Lower California. J. Ross Browne's *Mineral Resources of the United States*, 1868, pp. 630-639.

ward, as far as examined by the writers, the mesa structure is characteristic of the Pacific Coast, the table-lands rising to a height of 1,000 to 2,000 feet at comparatively short distances from the sea, and presenting bold bluffs of soft horizontally stratified beds, often capped by lava flows, which are evidently wearing away rapidly under the erosive action of waves.

“Lindgren, as a result of his observations in the vicinity of Ensenada de Todos Santos, divides the topographic features of the peninsula Sierra into three sections:¹

(1) The coast range, rising gradually from the sea to an elevation of 3,000 feet in a distance of 20 to 30 miles. Surmounting this area several minor ranges and sharp peaks attaining an elevation of 3,000 to 4,000 feet. A rapid descent leads from the divide of the coast range to—

(2) The interior valleys, an interrupted series of depressions in the middle of the chain at an elevation of 1,800 to 2,000 feet.

(3) The eastern range, rising rapidly from the valleys and continuing as an almost level plateau, with a gentle slope up to the peninsular divide and an abrupt, almost precipitous, descent to the desert. The elevation of this remarkable plateau is from 4,000 to 5,000 feet.

“This plateau region, which supports a considerable growth of pine forest, extends, according to the meager accounts obtainable, from the boundary southward about to latitude 31°, reaching its culminating point in the high mountain mass now known as San Pedro de Martis, which is apparently the same as the snow-capped mountain called in the Narragansett report “Calamahue,” or Santa Catalina (Caterina) Mountain.

“The area examined by the present writers, which extends 15 to 30 minutes north and south of the thirtieth parallel of latitude, is separated by a considerable gap of unknown country from that described by Lindgren. In this latitude the average elevation of the peninsula is about 2,000 feet, and that of its higher ridges may be taken at less than 3,500 feet. It is a singularly arid region, having practically no running water on the surface and very few permanent springs; nevertheless our experience has shown that properly located wells obtain a fair supply of water at depths of 20 to 60 feet. The climate is remarkably equable and healthful, being but little warmer than that of the coast region of southern California, and as a rule much drier. The diurnal changes of temperature are, however, very great. It is swept by continuous breezes from either coast, which appear to blow alternately about three days at a time, those from the Pacific being laden with more or less moisture, while the east winds are extremely dry. Like California, it has a rainy season in the spring, but this is generally but a few days' duration and extremely irregular and uncertain.”

* * * * *

¹ Notes on the Geology of Baja California, Mexico. Proc. Calif. Acad. of Science, I, 1888, p. 170. Idem, II, 1889, p. 1. Idem, III, 1890, p. 26.

"This whole region may be in one sense considered to be a mesa region, since at one time the present mesa formation extended from coast to coast, but at the present day the mesas are no longer continuous, and erosion has disclosed an underlying or buried topography, whose general features show considerable analogy with the more northern region described by Lindgren. The mesa belt proper adjoining the western coast is represented by a series of plateaus from 900 to 2,000 feet in elevation, separated by the deep canyon-like valleys of streams that drain the interior. Owing to the soft, crumbling nature of the beds, the escarpments are very abrupt, and the topography has something of the character of the Bad Lands of the Great Plains.

"The coast or western range is represented by a series of isolated peaks or ridges rising 1,000 or 2,000 feet above the general mesa level, which are partly connected together by flat-topped ridges base-leveled down to the average elevation of the highest portion of the mesa region, but which in geological structure and composition belong to the same system of uplift as the higher peaks.

"East of this range lie the interior valleys, broad, level, or gently sloping plains 10 to 15 miles in width and with an elevation above sea level of 1,800 to 2,200 feet, bounded and traversed by mesa-topped ridges and with occasional sharp peaks rising out of them. These interior valleys all drain to the Pacific through gaps in the western range and rise gently to the eastward, the same gentle westward slope being noticeable in the mesa-topped ridges.

"On the eastern edge of these valleys, at a distance of about 10 to 15 miles from the Gulf Coast, a most sudden change in topographical structure takes place. The broad, level plains, in which the drainage courses are so shallow that their direction of drainage is with difficulty recognizable, give place to deep, narrow, tortuous ravines, descending a thousand or more feet within a few miles of the mesa-topped divide. These ravines wind along a series of sharp jagged peaks, which evidently are the projecting summits of an older and partially buried mountain chain. The eastern range is represented in part by the summits of this buried range, in part by a series of isolated table-topped mountains rising to an elevation of 3,500 feet, which brings them above the summits of most of the sharper peaks to the eastward. On the immediate Gulf Coast is a gently sloping mesa, of varying width, at the base of the eastern range. To the south of the region visited, the buried mountains rise still higher than these table topped mountains and send out spurs to the westward, which apparently cut off the interior valley in that direction. To the north they do not rise above the level of the interior valley, and the mesa-topped ridges sweep over them, descending in a series of terraces or steps to the Gulf Coast.

"The rocks, of which this eastern buried range is composed, outcrop so frequently in the bottom of the interior valley that it is probable that this valley rests in part upon a plateau-like shoulder of the buried

range, and that its form was not unlike that of the granite plateau described by Lindgren in the latitude of Ensenada.

“From Gabb’s description it would appear that a similar topographical structure obtains for the part of the peninsula stretching south from latitude 29° to La Paz. The eastern range has for the most part a mesa-topped crest, broken here and there by projecting ridges, which stretch in part across the peninsula and separate the interior valleys. The interior valleys, set off successively a little more to the southward and westward, become more extensive southward, one being described as stretching from La Purissima to Todos Santos (of the south), a distance of 150 to 200 miles, with an average width of 10 miles. The western range is apparently still more indistinct as a topographical feature and is not recognized by him, but the western mesa region is spoken of as stretching in varying width from Magdalena Bay, in latitude $24^{\circ} 30'$, to Cape Colnett, in latitude 31° .”

(2) GEOLOGY.

“For purposes of geological description the region examined may be divided into the coast or mesa belt, the western range, the interior valley, and the eastern range. The immediate Gulf Coast was not visited.” On Plate 1¹ is given a generalized section across the peninsula along the line A–B. Topographical features at some distance from this line are brought in to illustrate the general structure. Though not drawn to scale, care has been taken to make the section as close an approximation to nature as the data would admit. Distances were estimated in traveling to and fro and checked by rough triangulations made with a prismatic compass. The vertical scale is intended to be about four times larger than the horizontal.

COAST OR MESA BELT.

“This area has an average width of 10 to 15 miles, and in it, so far as observed, no older rocks occur than horizontally bedded, loosely aggregated clayey sands, sandstones, and conglomerates, of which the lowest horizons carry characteristic forms of the Chico Cretaceous. In a higher horizon of this apparently conformable series a characteristic fauna of the Tejon-Eocene has been found, and in still higher beds a few forms of probable Miocene age were observed. None of these beds show evidence of any considerable disturbance, though in a few instances dips of 10 to 15 degrees and slight displacements with a throw of only a few feet have been observed. They have, however, been extensively eroded, and later deposits of post-Pliocene and possibly also of Pliocene age have been deposited upon their eroded surface. Recent eruptive rocks, both acid and basic, have cut through them and in places have been important factors in shaping topographical forms by protecting the softer beds from erosion.

¹ From Bull. Geol. Soc. of Am., V, 1894.

“The best exposures of the lower beds were found between Canoas and Bluff points [Plate 1.] where they present perpendicular bluffs, facing the sea, from a few hundred up to nearly a thousand feet in height. These are being rapidly undermined and eaten back by the action of the waves, so that between the two points the coast line forms a bow-like reentering curve, set back 3 to 5 miles from a line drawn between the points. From either point the land rises in a series of steps or broken terraces to an extensive plateau, cut on the sea faces by short, narrow, branching ravines and presenting in general continuous bluff faces inland.

“Midway in the reentering curve between Canoas and Bluff points is the Playa Santa Caterina, where is a gap a mile or two in width between the bluffs bordering the ocean, formed by a broad valley in which are two modern stream beds draining the interior region. They are divided at the shore line by a flat-topped ridge of Chico beds, near the top of which is the remnant of an ancient stream bed whose bottom is now about 100 feet above tide water, and which is filled by a conglomerate of large boulders and water-worn pebbles of massive rocks. This conglomerate, which is cemented by lime and iron, is so much more resisting than the soft clays of the Chico formation that the huge boulders that fall as the cliff is undermined by wave action form a point projecting out several hundred feet beyond the average coast line. These conglomerates are probably of the same age as those which are found at various points in the canyons of the interior, and their formation evidently dates back to a time when, after the carving out of the general system of modern drainage, the waters of the ocean reached a higher level than the present, and the old drainage channels were partially filled up to the then base level. Subsequent erosion, while cutting down to a somewhat lower level and following the same general lines, has often eaten more readily into the softer beds at the sides of these recent conglomerates and left patches of them still standing, which sometimes form one wall of the canyon a hundred or more feet above its present bottom.

“The modern stream beds from Playa Santa Caterina are almost at base level for some 10 miles inland, at about which distance eruptive rocks appear from under the Cretaceous and recent beds, and then rise rapidly, reaching an elevation of about 1,500 feet within 15 miles of the coast, on the partly buried slopes of the coast range.

“Both in the broad valley and on the mesa slopes are relics of terraces which evidence a successive rising of the land above the ocean.

“The lower beds exposed in the bluffs along the coast have a gentle inclination northward and southward from Sandstone Point, about 3 miles north of Playa Santa Caterina, where massive sandstones form a slightly projecting headland. In these sandstones carbonized plant remains, too indefinite for identification, were found, and in the cracks of the immediately overlying sandy clays were traces of petroleum. From

these beds and from calcareous layers about 200 feet above were obtained the following forms, as determined by T. W. Stanton:

<i>Arca breweriana</i> , Gabb.	<i>Inoceramus</i> , sp. undetermined.
<i>Baculites chicoensis</i> , Trask.	<i>Ammonites</i> , sp. undetermined.
<i>Tessarolax distorta</i> , Gabb.	<i>Ostrea</i> , sp. undetermined.

“They correspond with forms found in the Chico beds of California and Oregon.

“From rolled pebbles of impure limestone obtained along the beach to the south of the Playa, which had evidently fallen from the cliffs above, and from a bed of similar composition in place at what was assumed to be about 1,200 feet higher in horizon, at San Carlos anchorage (collected by A. D. Foote), 8 miles north of Bluff Point, the following forms were identified by T. W. Stanton:

<i>Cardita planicostata</i> , Lam.	<i>Tellina</i> , sp. undetermined.
<i>Leda gabbi</i> , Conrad.	<i>Turritella</i> , sp. undetermined.
<i>Urosyca caudata</i> , Gabb.	<i>Dentalium</i> , sp. undetermined.
<i>Nucula</i> , sp. undetermined.	<i>Crassatella</i> , sp. undetermined.

and are considered by him to belong undoubtedly to the T^éjon Eocene.

“The beds carrying Chico and T^éjon fossils were not observed in direct superposition, but from the negative evidence that no decided unconformities were detected at any of the points examined, it is assumed that the two series are conformable, or that in any case no considerable disturbance of the strata took place between the times of their respective depositions.

“The great mesa or plateau, 15 miles long and 6 to 8 miles in width, which extends from the valley of Santa Caterina northward beyond San Carlos, has an elevation of from 1,800 to 2,000 feet, being somewhat higher at the northern end. The greater part of its surface is apparently capped by basalt flows, which have protected it from erosion. From a distance can be distinguished conical points rising above the level of the mesa, known as the “Sombrero,” the “Hat,” etc., which resemble recent craters in general form. At one point on the coast, fragments of the basalt, cemented together by crystalline calcite, have fallen to the foot of the bluff in huge masses and form a projecting point on the coast line.

“For about a mile beyond Sandstone Point the beach is covered with beautifully rounded pebbles of porphyries and a great variety of hard rocks, mostly older eruptive, whose material must have come down a ravine which drains the western face of the plateau and descends very rapidly from its summit. As no such pebbles were observed in the Chico or T^éjon series, nor on the beaches to the south where no upper beds remain, it is thought probable that the mesa sandstones, which are characterized by an abundance of eruptive material, may form the upper portion of this plateau.

“Northward from San Carlos, as seen from the ocean or from commanding points of view in the interior, the same character of beds,

with their characteristic bad-land topography, extend northward to the Rosario Ravine.

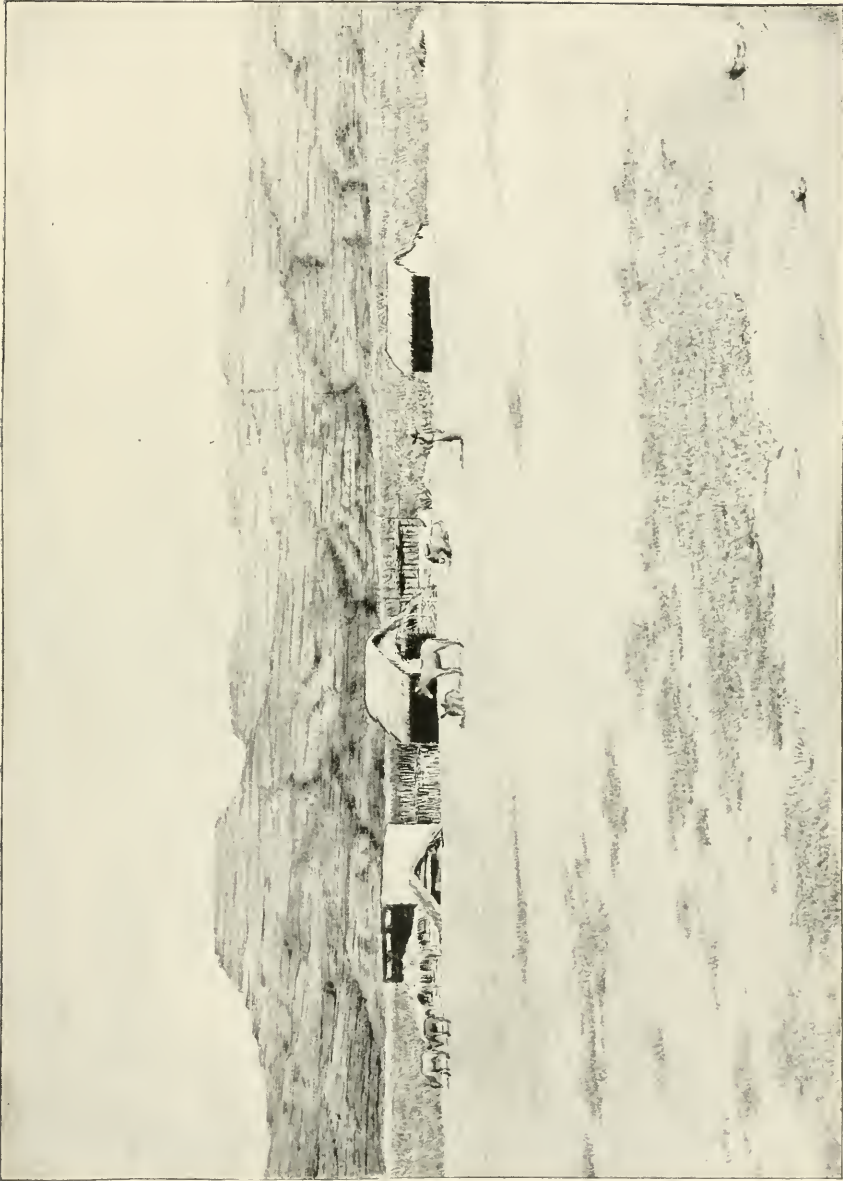
“The hamlet of Rosario is situated a few miles from the sea, in this ravine or canyon, which extends inland for some 10 or 15 miles with very gradual rise of its beds, and carries a small stream of running water that in dry seasons sinks below the surface sands. [Plate 2.]

“The cliffs of the canyon walls are eroded into castellated forms that recall the buttes at Green River, Wyoming, familiar to travelers on the Union Pacific Railroad. Opposite Rosario the bedding planes have a dip of 15 degrees to the northeastward, while the surface of the mesa is quite horizontal, and from the pebbles and recent shells on its surface evidently represents a higher level of the ocean waters, which have base-leveled it at about 1,000 feet above present sea level. For a few miles north of the mouth of the Rosario Canyon the bluffs come close to the present coast line and then gradually retreat, until opposite San Quentin they are about 8 miles inland. The immediate shore is first a terrace about 200 feet above the sea level, then at the mouth of the Socorro Valley a triangular-shaped Quaternary delta hardly 50 feet above sea level, covered with rolled pebbles and recent marine shells. The older beds forming the mesa region in this latitude, though not markedly different from those between Bluff and Canoas points, contain a larger proportion of conglomerate material and several fossiliferous beds of recent looking shells, among which were recognized *Mytilus californianus* and a fragment of *Pecten*, like *P. cerrosensis*, which Dr. W. H. Dall regards as indicating a probable Miocene age. These are the beds seen by Gabb on his trip and called by him “mesa sandstones.” No evidence of unconformity between these and the T \acute{e} jon beds was observed, and it seems probable that they may constitute the highest part of the mesa at Bluff Point, but this was not determined by fossil evidence.

“Northward from Socorro River the bluffs of the mesa formation retreat gradually from the ocean, and at San Quentin are separated from it by the sandy plains of Santa Maria, about 8 miles wide and but a few feet above sea level, which are the northern continuation of the depressions of the bay of San Quentin. The immediate coast line at San Quentin is formed by a group of six conical hills of basalt, from 400 to 800 feet high, which, judging from the uneroded character of the lava flows which have issued from their flanks, must be of very recent eruption. One of these flows extending southward about 7 miles forms the low, narrow tongue of land known as Cape San Quentin. It is evidently the superior resistance of these hard lavas that has thus far protected the plains of Santa Maria from the encroachments of the sea.

WESTERN RANGE.

“In the present topography the western range is very ill defined, and consists of a number of irregular ridges and isolated mountain masses 15 to 20 miles from the coast, the highest summits of which are probably



VIEW AT EL ROSARIO, LOOKING WESTWARD ACROSS THE VALLEY. MESA SANDSTONES IN THE DISTANCE.



LOOKING SOUTHWEST TOWARD SAN FERNANDO, WHICH IS ON THE FARTHER SIDE OF THE RANGE.
The view shows upturned sedimentary beds in the middle distance.

less than 4,000 feet above sea level. Between the peaks are broad, transverse valleys and flat-topped ridges whose higher summits have the same general level with those of the higher plateaus of the mesa region—that is, about 2,000 feet. Rounded pebbles and an occasional fragment of recent shells were found on these summits, which strengthen the opinion that this was a pene-plain of recent times, probably formed at the time of the greatest submergence since the deposition of the mesa sandstones.

“The range was traversed on two lines—that of the arroyo of Santa Caterina, shown in the section [Plate 1], and that of the Rosario arroyo. The river bed or arroyo of San Fernando crosses it about midway between these two. Near the mission of San Fernando is a considerable development of sedimentary beds, one of which is a much altered bluish limestone containing unrecognizable fossils, which is probably either of early Mesozoic or Paleozoic age. [Plate 3.] The beds have a steep dip to the eastward; at one point are overturned against a considerable body of acid eruptives and diorite. On the line of the Rosario arroyo it consists mainly of diabase, with acid eruptives and diorites on their eastern flank. The latter cut the diabases, and are succeeded on the east by an extensive flow of rhyolite capping the mesa ridges which extend out into the interior valley. A little farther south diorites seem to form the main mass of the flat topped ridges which here represent the range, and which are flanked on the east, at the border of the mesa region, by recent tuffaceous rocks, in which is found one of the few springs of the region. Along the line of the section south of San Fernando, diorites again predominate, and in these occur deposits of copper sulphides, one of which has been quite extensively mined.

“It was not possible to determine the relative age of all the varieties of eruptive rock observed, but the older eruptives are evidently pre-Chico, while some of the recent eruptives are certainly more recent than the mesa sandstones.

“The rocks described above as acid eruptives are compact and sometimes brecciated quartz-porphyrines of greenish and brownish colors, at times quite aphanitic, and again showing small phenocrysts of feldspar and more rarely quartz, sufficiently developed to be recognizable by the naked eye. Chemical tests in the more aphanitic varieties yield 70 to 75 per cent silica. The more common form of the diorite is a pinkish gray, finely granular rock, which in thin section shows a hypidiomorphic granular aggregate of quartz and triclinic feldspar with pale green hornblendes, in part or wholly altered to epidote. There are also a few sphenes and the usual iron ores.

“In the upper Santa Caterina Valley, which crosses the range diagonally in a nearly north-and-south direction, a very considerable mass of underlying granitic rock is exposed over an extent of about 10 miles along the bottom of the valley, which apparently grades into the finer-grained diorites surrounding it. Along the center of the valley a low ridge of rounded blocks of this very massive rock has the appearance

at first glance of a morainal ridge with huge erratics, but examination shows that the rounded forms are merely the results of weathering under the peculiar climatic conditions of the region. The granite is an even-grained granular rock, thickly studded with small black scales of mica and small hornblendes. In thin section it shows a hypidiomorphic granular aggregation of quartz, feldspars, black mica, and deep green hornblende, with a sprinkling of iron ores, apatite, and rarely zircon. It resembles the granites of the Sierra Nevada.

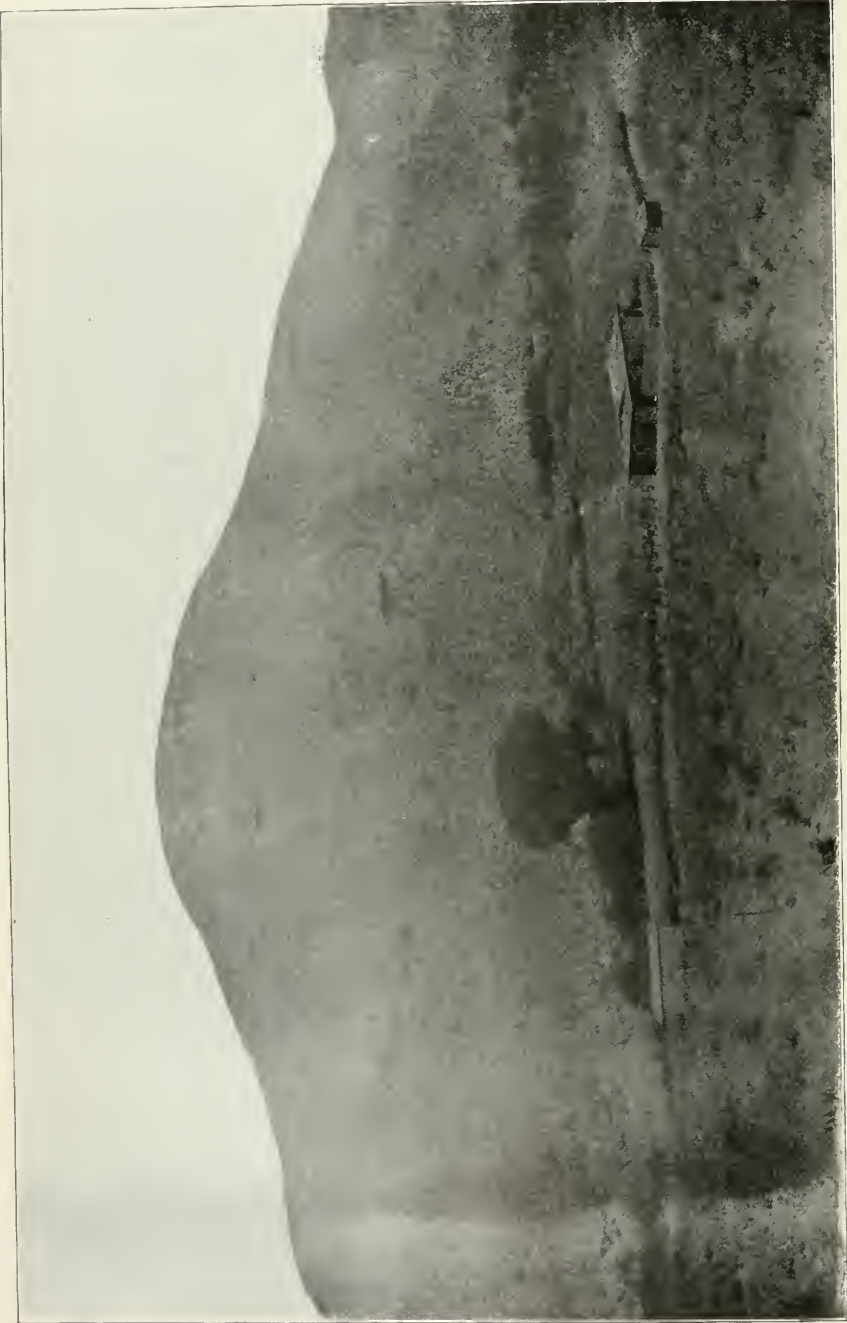
“Westward along the line of the section this granite is succeeded by the finer grained quartz-mica-diorite described above, and then by a belt several miles in width of recent eruptives, which form low rounded hills adjoing the mesa region. These appeared to be mostly rhyolites, and to have cut through the sedimentaries of the mesa region, though it was not possible to obtain unquestionable evidence of the latter fact.

“On the east, or at the head of the Santa Caterina Valley, capping the flat ridges which form the western divide of the interior valleys, was found a rather remarkable rock of the hypersthene-andesite type, showing microscopically small olivines and white feldspars, with occasional black hornblendes in a dark gray matrix. In thin section it shows a decided andesitic ground mass of augite and plagioclase micro-lites, with the usual iron ores and abundant colorless olivines, pale hypersthene, small pale green augites, and an occasional dark basaltic hornblende with black border.

“Abundant chalcedony and flint concretions, with dendritic markings, constitating the popularly known moss agates, are found on the eastern slopes of these ridges.

INTERIOR VALLEY.

“The interior valley which was visited by the writers is probably that designated by Gabb as the plain of Buena Vista. In about latitude 30°, or a little north of the line of the section, its width on a northeast-southwest line, or at right angles to the trend of the peninsula, is over 15 miles, an almost level plain with a slight rise toward its eastern rim, which rests on the submerged flanks and crests of the eastern range. Its elevation varies from about 2,000 feet on the western to 2,300 feet on the eastern edge. To the southward its width is contracted by the encroachments of the bounding ranges which send out spurs or ridges into it, and in the far distance appear to merge together. The spurs from the eastern range are flat-topped in great part and composed of horizontally-bedded material, which, where examined, consisted largely of volcanic ash carrying abundant fragments of basic eruptives. These are evidently the mesa sandstones of Gabb. Those from the western range, on the other hand, are composed largely of eruptive rocks and appear to be projecting portions of the older mountains laid bare by erosion, but in a few cases are mesa-topped ridges, capped by horizontal lava flows of later age than the mesa sandstones.



SAN JUAN DE DIOS.

“To the north the valley appears to grow wider, and out of its midst rise a few conical peaks, the most prominent of which, known as San Juan de Dios [Plate 4], about 20 miles north of the line of the section, has a remarkably graceful outline and a probable elevation of over 4,000 feet. It is composed, in great measure, of eruptive rocks, among which felsite, diabase, liparite, and basalt were recognized, while erosion has disclosed on one side an underlying coarse quartzite. At its base is one of the rare springs of the region. Similar peaks are seen to rise out of the plain far to the northward at probable distances of 10 to 15 miles apart.

“The slope of the broad stream beds in the lower part of the valley is so imperceptible that the direction of its drainage is difficult to determine; but aneroid observations indicate that the portion examined is drained through the gap in the western range at the ruined mission of San Fernando (elevation about 1,800 feet), and thence probably by the San Fernando River bed to the Pacific Ocean. Limited portions of the eastern edge to the north of the line section are drained by deep and narrow arroyos of more recent formation into the Gulf of California. The present bottoms of the valleys are occupied by recent deposits of porous limestone or travertine and coarse conglomerate with calcareous cement containing rounded fragments of both eruptive and sedimentary rocks in great variety and varying size up to several feet in diameter. The evidence of wells which get water in the lower parts of the valley at 40 to 60 feet below the surface and of adjoining mesas in the valley, which afford partial sections, show a present thickness of little over 100 feet of these beds; but their elevation in shallow ravines—notably the one on the southeastern edge of the Buena Vista plain, in which are the New Pedrara onyx deposits, and remnants of calcareous conglomerates remaining on the flanks of the bounding ridges at other points—indicate that the original thickness of these deposits may have been several hundred feet, and that the greater part has already been removed by erosion. No fossil evidence was obtained as to their absolute geological age, but the character and position of the deposits indicate that they were laid down in an inclosed body of water, probably an interior lake of comparatively recent date. What remains of these beds barely serves to smooth over the inequalities of the underlying mountains, whose component rock masses often outcrop across the stream beds, especially along the eastern portion of the valley. Even where there is no actual outcrop the appearance of frequent fragments of granite or sedimentary rocks, as the case may be, indicate that these rocks are to be found in place near by and not far from the surface. In some cases the ground is whitened over considerable areas by the abundant small fragments of vein quartz, resulting from the disintegration of the underlying slates.

“The relative age of the interior lake beds may be assumed to bear some relation to that of the calcareous conglomerate already mentioned

which partially filled the earlier canyons of the Pacific Slope. After the deposition and subsequent elevation of the mesa sandstones, which are assumed to be of late Tertiary age, there must have been a long period of erosion, during which the interior valley was carved out and drained through the deeper canyons running to the Pacific Ocean. This was apparently followed by an extensive submergence of 2,000 feet or more, since which time the whole peninsula has been gradually rising by periodic movements, with considerable base leveling in the intervals.

“The present elevation of the mesa-topped ridges of the western range indicates a base leveling of the region at an elevation of about 2,000 feet above present sea level. This might have filled up all the outlets of the interior region across the western range and admitted of the inclosures of a body of water up to that level; but to account for the present position of the deposits on the eastern side of the valley, it is necessary to assume a subsequent differential movement by which that side has been raised a few hundred feet more than the eastern side.”

EASTERN RANGE.

“The older or buried eastern range is made up of granite and gneiss, with highly altered sedimentary strata flanking it on the northeast, which stand either vertical or with a steep dip to the eastward and strike about northwest, or somewhat more to the west of north than the general trend of the peninsula. The present divide, on the other hand, follows the general trend of the coast line at a distance of 10 to 15 miles from it, and is marked in general by abrupt escarpments along the eastern edge of the desert plain.

“To the north of the limits of the field of observation, beyond the thirtieth parallel, the summits of the older range have been planned off and their depressions so evenly filled up by the more recent deposits that they play no part in the present topography of the country. To the south, however, where, east of the present divide, they have been denuded of the more recent deposits, or still farther south, where they were never completely covered by these deposits, they form conspicuous and striking topographical features, in marked contrast with the prevailing horizontal lines and broad shallow valleys of the western portion of the peninsula.

“In the northern region the desert plains and flat-topped ridges of mesa sandstones rise very gently from the west to the divide line, which almost invariably presents an abrupt escarpment to the east, overlooking a region deeply scored by narrow gorges several hundred feet in depth, with almost vertical walls. Here the divide line is marked by occasional isolated table topped buttes, capped by rhyolite, which rise 500 to 1,000 feet above the desert level and serve to mark the original level of the mesa sandstones, which have been protected from erosion by the cap of more enduring rock. These rhyolites are generally of

earlier date than the lake beds. The top of the mesa sandstones as thus determined is about 3,000 feet above present sea level, and their maximum observed thickness 800 feet. Angite andesite flows, apparently of more recent date, are found capping intermediate portions of the divide. The contrast in topographical structure between the region east and west of the divide is here less marked than in the region to the south, as on both sides approximately horizontal lines prevail. The surface of the mesa-topped ridges slopes upward toward it from either direction, but the slope is much greater on the eastern side and the ridges descend toward the gulf in a series of step-like terraces, while the whole eastern region is deeply scored by narrow, steep-sided ravines from a few hundred to a thousand feet in depth. The upturned beds of the metamorphic series are well exposed along the walls of these ravines, often reaching the surface of the intervening mesas. They are also seen in the shallow stream beds of the desert plains on the west, and, as already remarked, often outcrop through the thin covering of the lake beds for a considerable distance out on to the desert.

“South of the thirtieth parallel the summits of the buried range rise gradually, and east of the divide are completely denuded of any covering of recent beds that they may have had. They also spread out to the eastward, approaching more and more closely to the gulf coast, and south of the limits of the field of observation, or 20 miles south of the thirtieth parallel, they constitute a high granite range extending 10 or 15 miles westward into the interior valley and effectually cutting off any view of the country beyond.

“The region in the vicinity of the New Pedrara onyx deposits, a few miles south of the thirtieth parallel, shows well the general structure of the eastern range as presented in generalized form in the section on plate 1, and will hence be described in some detail.

“The principal onyx deposits are situated in a shallow ravine or eastern arm of the interior valley, between two ridges of mesa sandstone, at an elevation of about 2,300 feet. Since the denudation of the granite bed of this ravine of its former covering of mesa sandstone it has been filled to a depth of about 100 feet by alternate beds of travertine and calcareous conglomerate, which were probably contemporaneous and at one time continuous with the lake beds of the interior valley.

“The winding bed of the modern stream cuts into the travertine deposit, exposing at one place a cliff of over 20 feet in height, showing three distinct layers of “Mexican onyx,” one of which is over 3 feet thick, interstratified with the travertine, while for a distance of nearly a mile down the ravine sheets of the more resisting onyx cap the little travertine mesas on either side. The occurrence of the onyx, which is a thermal spring and surface deposit in successive layers, separated by travertine and resting on conglomerate, indicates a probable successive rise and fall of the waters of the lake where the travertine was deposited, which would have admitted of some slight erosion of the deposit in

the periods when the lake waters had temporarily retreated—a hypothesis that was confirmed by the finding of some fragments of onyx in the upper travertine beds.

“At the head of the ravine the travertine beds end abruptly in an escarpment, beyond which one descends rapidly 500 feet through winding ravines, between sharp, jagged ridges of a metamorphic rock, to the bed of the Tule arroyo, a winding, V-shaped gorge which runs northward about 10 miles, then northeastward to the Gulf of California, draining the whole region east of the divide. At one point this gorge widens out into quite a valley, in which are travertine deposits about 50 feet in thickness, with layers of onyx in the upper part. Relics of the thermal action are found at the present day in a little effervescent spring, known as the Volcan, which issues from the top of a dome-shaped mound of calcareous tufa in the narrow bottom of the ravine before it opens out into the valley containing the travertine deposits. [See Plate 5.]

“These travertine deposits are entirely isolated and have no present connection with those of the interior valley to the east of the divide, their level being about 400 feet lower than the divide, where the nearest lake-bed deposits end. The similarity of their composition, their relations to the underlying rocks, to the onyx formation, and to modern erosion, all suggest, however, a common origin with the lake beds, and if once connected with them there must have been a differential movement since their deposition which produced the present difference of level.

“Beyond the Tule arroyo to the eastward arise a series of sharp, jagged peaks which attain a maximum elevation of about 3,000 feet, deeply scored by a most intricate system of deep, winding ravines, quite impassable except to foot travelers, and which are in most striking topographical contrast to the level valleys and plains of the region west of the divide. Within these hills at various points are placers from which the Mexicans obtain considerable coarse gold by dry washing during the months immediately following the spring rains. At other seasons there is not enough water to support life. They are composed of distinctly stratified sedimentary beds standing on edge and striking northwest and southeast, but which are so highly metamorphosed and so blackened and splintered by the weathering of this arid region that their original character can no longer be determined. They are mostly dark siliceous slates and fine-grained mica-schists. Some beds have all the external appearance of limestones in their granular structure and thin white veins, but their present composition shows no trace of lime and is almost entirely siliceous. They are traversed by well-defined dikes, which are also intensely altered.

“Among the more striking rocks in this metamorphic series, at the northern limits of the area observed, was a fine-grained hornblende rock which microscopic examination shows to be properly an altered dio-



THE TULE ARROYO, WITH RECENT DEPOSITS OF CALC TUFA.



rite. The ground mass consists of an aggregate of plagioclase feldspar, apparently anorthite, with fibrous hornblende containing inclusions suggestive of interpolations of hypersthene and diallage. Associated with this was a grayish massive rock thickly studded with short, stout crystals of black hornblende 2 to 5 millimeters in diameter and 5 to 8 millimeters in length. Microscopical examinations show the ground mass to be a granular aggregate of almost colorless augites with a few plagioclase feldspars, and the rock apparently belongs to the group of hornblende-pyroxenites of Williams. When collected, these rocks were supposed to be interstratified with the metamorphic series, as their outcrops had the same general strike; the result of microscopical examination indicates that they are probably altered intrusive sheets.

“The flat-topped ridge of mesa sandstones south of the ravine in which the principal New Pedrara onyx deposits occur is thickly strewn with subangular blocks of augite-andesite, which have apparently weathered out as the soft ash of which the beds are composed has worn away. At the eastern extremity of this ridge, on the very crest of the divide, is a high basalt-capped mesa, nearly a mile in diameter, called by us Bluff Point. It has an elevation of about 3,500 feet, and overtops all the highest summits within a radius of 15 to 20 miles, thus offering an admirable point of view from which to study the physical structure of the region. The basalt cap has an aggregate thickness of 500 feet, and consists of an upper layer of dark vesicular olivine-bearing rock 350 feet in thickness resting on 150 feet of gray, fine-grained rock containing abundant large crystals of olivine. The upper layer has a dark smoky glass base with the usual microlites of feldspar and augite and small phenocrysts of augite, olivine, and feldspar. Between these flows a zone of decomposition several feet in thickness, colored brilliant red by peroxidation of the iron, makes a prominent line, visible from a great distance, on the bluff faces which almost completely surround the mesa.

“The surface of the mesa has a gentle slope westward and ends to the eastward in an almost perpendicular escarpment overlooking the Tule arroyo 1,500 feet below, which has here widened out into a considerable valley that drains the northern slopes of the White range far to the south. Beyond this valley, partly cutting off the view of the Gulf of California, lies the group of dark rugged peaks of metamorphic slates called the Volcan Peak group, which the Tule arroyo almost completely encircles in its circuitous course to the sea. Through the gaps in this range can be distinguished the pale blue waters of the Gulf of California and occasionally portions of the coast line, as well as several of the group of small islands which lie a few miles off the shore in this latitude, and whose abrupt outlines show them to be probably projecting points of the buried metamorphic ranges.

“The arms of the interior valley, which lie to the south and west of the Bluff Point mesa, have a floor of granite which is entirely denuded

of the mesa sandstone covering and of the lake beds, if the latter ever covered it. The granite is a light gray rock of normal type, consisting of two feldspars, quartz, and both white and brown mica. Hornblende was not observed. From general appearance and association it would appear to be a distinct and older rock than that found in the western range. To the south of these valleys the White range, composed of the same granite, stretches some 10 or 15 miles east and west across the peninsula, and apparently cuts off in great measure the interior valley in this direction. As no contacts were found, it was impossible to determine the relative age of the granite and the metamorphic series."

ITINERARY.

The party left San Quentin for El Rosario, some 40 miles to the south, late on the afternoon of July 19, our conveyance consisting of a "dead ex" wagon drawn by a pair of mules. That night we succeeded in making but about 7 to 9 miles, nearly the entire distance being over level sand plains, either quite bare or covered with cacti, sage brush, and in places with dense growths of strong-smelling shrubs with small harsh leaves and thorny branches. We encamped that night, as indeed every night, in the open air, and were on the road again by 6 o'clock the morning following. For nearly 10 miles the route lay along the hard sands of a beautiful beach facing the open Pacific. Thousands upon thousands of dark-colored sea fowl flew back and forth in long undulating lines, while small flocks of gulls, curlews, and an occasional brace of strong-flying pelicans enlivened the monotony of the trip. The sands were beautifully hard, clean, and white, with comparatively few shells or other indications of marine life. The disk-like shells of echinoderms, an occasional giant clam, and more rarely yet a few abalones were the most conspicuous forms. But this part of the trip was only too soon at an end, and leaving the beach we turned inland, journeying for the rest of the day over a nearly level plain with high mesa sands to the east. In the distance from San Quentin to El Rosario fresh water was found but twice, and though in some cases the soil was good the lack of moisture leaves the country essentially a desert. This indeed is the condition of affairs throughout the entire region traversed, excepting where along the few streams a crude form of irrigation by the native Mexicans was carried on. Along the beach above alluded to the soils were light and sandy and bore no vegetation of sufficient size or proper foliage for casting a shade. Such plants as existed consisted mainly of cacti and small, nearly leafless, thorny shrubs. Rarely the pole-like form of a giant cactus or an agave appeared in the distance, but much more abundant were elongated, serpent-like forms, 3 or 4 inches in diameter and of all lengths up to 10 or more feet, growing singly or in clusters.

A miserable variety of sage brush, with its half dead, half living, scrawny branches, was everywhere, while an occasional small, tubular-

shaped, very pretty pink flower showed up in strong contrast with the general dreariness of the land. An "ice plant," an insignificant little thing growing close to the soil, of a green and wine red color, covered all over with jelly-like drops or tubercles, added also a slight amount of attractiveness, or at least gave interest to the scene. Small lizards darted about, and an occasional quail, jack or cotton-tail rabbit, a few butterflies, a large species of ichneumon fly, a few grasshoppers (some species of *Edipoda*), and a black yellow-spotted spider which builds strong webs on the shrubs, were about all that was visible in the way of animal and insect life, though in the soil, at the foot of the shrubs, I found occasional empty spiral shells of a land mollusk, the *Helix stearnsiana* of Gabb. After leaving San Quentin nothing whatever in the way of reptile life was seen, although immediately about San Quentin a species of rattlesnake was said to be quite abundant. Beyond Rosario, with the exception of quail and mountain sheep and antelope well over to the east coast, no forms whatever of wild animals were observed, and even the numerous burrows of small nocturnal mammals, so abundant toward the north, were almost entirely lacking. About dusk we reached the divide which marks the limit of the desert here, and went rattling down the steep sandy slopes toward El Rosario mission and the sluggish shallow stream of the same name, but dignified in this country of arid wastes by the name of river.

We reached the bottom just about that hour when it is too dark to see anything distinctly, to find a flat valley, perhaps a mile in width, hedged in on either side by steep bluffs of bare friable sandstone, and covered, where not cultivated, by a dense growth of greenish, pungent-smelling, almost leafless shrubs and a few willows. The short twilight came quickly to an end and left us lost, stuck in the sand in a dense growth of brush, from whence we were finally extricated through the aid of a Mexican, and about 9.30 p. m. found our way to an adobe hut, where we spent the night.

Five o'clock the following morning, July 21, found us once more astir. While the head of the party was making arrangements for pack and saddle animals, I improved the opportunity to utilize notebook and camera. El Rosario (Plate 2) consists of a few adobe huts scattered for a mile or more along the nearly level plains bordering on the river. From a historical standpoint its most interesting possession is the ruin of an old Franciscan mission, such as were once so abundant throughout the Mexican-Spanish possessions on this coast. The original buildings are now almost entirely obliterated, only portions of the thick, massive adobe walls remaining standing. A small building of modern construction now contains the altar, crude images of the saints which resemble nothing more than grotesquely large wooden dolls, and ancient vestments, such as have escaped destruction. Two bells, each about 20 inches in height, are hung upon a T-shaped post made from the knees and other timbers of a wrecked vessel. One of these bells

bears the date of 1784 and the other 1800. A few miles up the river we saw in the distance ruins of an extensive series of buildings once forming a part of the mission, but now given over to silence and the basking lizard. In exploring these ruins and still others at San Fernando, one could not but be impressed with the fact that, objectionable as may have been the system from a purely political standpoint, as a means of bettering the immediate condition of the people it was certainly preferable to anything since inaugurated. In the place of the thriving villages of no mean size which here and there dotted the land wherever was sufficient water for irrigation, of well-kept adobe houses and churches, vineyards, orchards of figs and peaches, of gardens and fields of grain, are now scattering huts in midst of ill-kept gardens or barren plains. Shiftlessness, squalor, desolation, and barrenness now reign supreme, where once was thrift and apparent prosperity.

The buildings at El Rosario are, I believe, without exception, of adobe—one-story affairs with thick walls and roofs of poles thatched with straw or palm leaves, and with floors of stone or hard-trodden dirt. The schoolroom of the village was built of poles standing against the side of one of the adobe houses, and rudely interwoven with sugar cane. In this I found a dozen or so little bright-eyed Mexicans under the instruction of a male teacher whose years must have numbered at least 60. During school hours each scholar studies aloud, and the confusion produced can be imagined. Now one voice in its jabbering monotone would prevail; and now another, now louder, now softer, rising and falling in irregular cadences such as would shortly render an Eastern teacher insane, but in the midst of all of which the Mexican conducts his recitations and administers his punishments, corporeal and otherwise, with a calmness and indifference that led me at times to doubt his power of hearing at all. All about the houses is dirt and sand; no lawns, walks, or roadways. In the yard, inclosed by adobe walls and thorny poles of the fouquiera, were stretched lines, on which are drying long strips of meat. On the flat below ran the irrigating ditches, where women were washing clothes, and which are bordered with fine large fig trees full of ripe, purple fruit, and beyond which are peach orchards and gardens.

Shortly after noon of the 21st our outfit was declared ready and we mount and start, said outfit consisting of three horses, two mules, and one burro for saddle purposes, and two pack mules to carry provisions and camp utensils. The first 10 miles of our course lay due north up the Rosario Valley, the river bed becoming shortly little else than a dry ravine, with here and there an adobe house with the usual type of occupants.

At the end of perhaps 10 miles we turned to the east up a lateral canyon or arroyo toward the mountain range, at the foot of which, by the side of a diminutive muddy spring, we made our camp. The stream, now dry, here enters a deep, steep-walled canyon, cut in granitic dio-



GIANT CACTUS (*Cereus pringlei*).



FOQUIERA COLUMNARIS.

rite, which seems to form the main mass of the hills, though in the dry stream bed are abundant bowlders of granite, diabase, and more rarely liparite and andesite.

The next morning it was found that our animals, which had been merely hobbled in order that they might browse on the mesquite, had strayed so far that it was nearly 11 o'clock before we were once more in the saddle. In the meantime, while engaged in pursuit of the animals, the camera was more than once brought into requisition, some of the results being here reproduced in Plates 6 and 7. The giant cactus, *Cereus pringlei*, Plate 6, is about 25 feet in height by 20 inches in diameter at the butt.

Larger forms, perhaps 35 to 40 feet in height, occur, but this was selected for photographing simply on account of its accessibility and from its being in fruit, as shown in the knob-like excrescences near the top. This fruit consists of a beautiful dark carmine pulp, with black seeds, inclosed in an envelope or rind so beset with small needle-like thorns that he who plucks needs fingers of brass. The appearance of this pulp in that dry, hot region was tempting in the extreme, but the realization disappointing, it being almost tasteless, and even failing to quench the thirst. These awkward forms, resembling nothing more than clustered mill logs standing on end, were quite abundant, though widely scattered. Some were straight and limbless as saw logs; others gave off three or four or more clumsy branches a few feet from the ground, as shown in the illustration.

Another striking form seen here for the first time is the *Fouquieria columnaris* shown in Plate 7, and which becomes more abundant on the inland plateau. Although in greater dimensions, some 40 feet in height and 15 to 18 inches in diameter at the base, these strange forms were readily cut down with the back of my geological hammer, and showed in cross section a structure not greatly unlike that of our ordinary Eastern sunflower (*Helianthus annuus* Linnæus) in that they have a thin exterior or rind of a greenish white color and an interior core of white pith-like material.

The numerous branches, which are about the size of an ordinary lead pencil, pass directly through the hard, woody rind into the pith. When the plant dies, the limbs fall out, the pith shrinks away and decays, leaving the trunks in the form of collapsed elongated cylinders full of spirally-arranged perforations. These branches are very abundant, and project uniformly in every direction, sometimes to a distance of 2 feet or more. They are stiff, harsh, and thorny, and it was found possible to gain access to the trunk without seriously tearing the flesh only by turning up one's coat collar, putting on gloves, bowing the head, and backing in. Even then the work of cutting through the bark is disagreeable, though the bark or rind is itself thin and tender.

A landscape of these pole-like forms, with their thorny branches and few small, brittle, thick, yellow green leaves is weird in the extreme,

and particularly so about dusk. Dry, hot, leafless, noiseless, and apparently lifeless, it conveys vividly to the imagination the idea of a burnt-out world. (See Plates 3 and 8.)

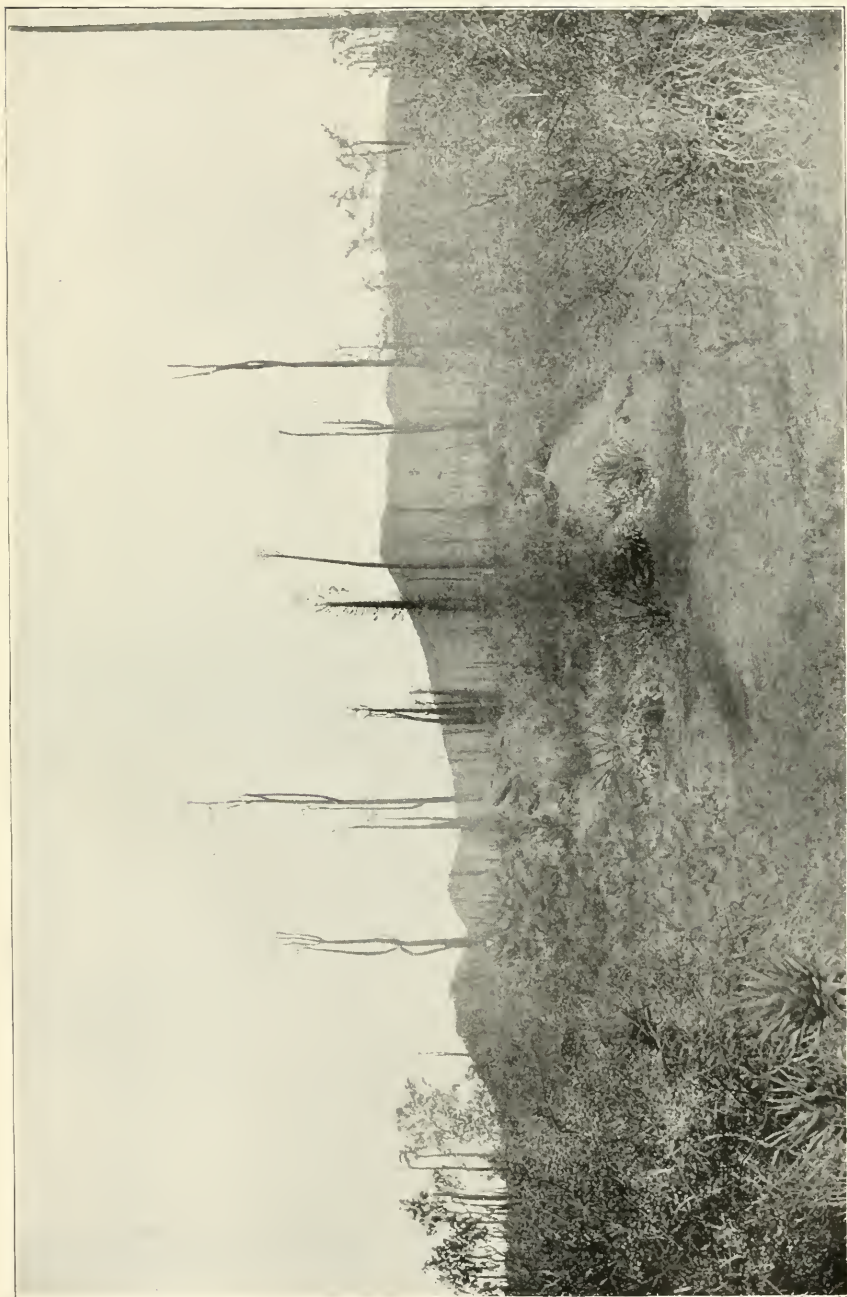
The writer is informed by Chief Botanist F. V. Coville, of the Department of Agriculture, that this plant was first described by Dr. Albert Kellogg nearly forty years ago, under the name of *Idria colum-naris*,¹ a new species of the family Fouquieraceæ, the description being based on specimens brought from Lower California by Doctor J. A. Veatch. The validity of the species was afterwards questioned and the plant doubtfully referred to *Fouquieria spinosa*, until in 1889 Mr. T. S. Brandegee fully established its distinctness from that species.²

As we ascended the mountains and passed the crest to the plateau on the east, the country became, if possible, more and more forbidding. The scanty soil and scattering growth of desert plants quite fail to cover the rocks, which stand out bare and hot, weathered to a dull reddish color. There is absolutely nothing that can cast a shade or boast a thornless leaf. Yet there were beautiful and interesting things, if one could but stop under that scorching sun, to admire. A barrel-shaped cactus from 6 inches to 4 feet in height, with long strong sharply recurved thorns, shows delicate green and pink tints, and often has a circle of beautiful deep scarlet flowers on the top. The agave begins to appear; a little insignificant cluster of leaves growing on vertical cliffs takes the form of a rose, and is coated with a flour-like bloom. The tints are delicate greenish white, sometimes pinkish, and when one can rid himself of the idea that the whole country is accursed, he finds it beautiful in the extreme.

We camped that night (the 22d) on the banks of a stream no longer running, but yielding in standing pools sufficient water for our immediate needs, passing on the way the only habitation seen between Rosario and San Juan de Dios. Mesquite grew abundantly along the dry bottoms, and there was a plentiful supply of quail, but no other forms of animal life were seen. From this point to San Juan de Dios the most striking feature of the landscape are the rounded, boss-like forms of the hills, due to the weathering of the granular, massive diabases and diorites of which they are composed. The region is one of limited rainfall, but subject to great diurnal changes of temperature. The agents of disintegration are therefore heat and cold, and as a result the débris from the massive eruptive rocks consists mainly of angular fragments, each of the larger fragments consisting of an aggregate of minerals, scarcely at all discolored by oxidation, and differing from the parent rock only in their state of partial disaggregation. This gravel and sand, disturbed but little by other than wind erosion, accumulates on the slopes until the outcrops become largely buried in their own débris and partake of the rounded character noted above. During the

¹Proc. Cal. Acad., II, 1859-60.

²Proc. Cal. Acad., 2 ser., II, 1889.



CHARACTERISTIC LANDSCAPE, INTERIOR OF PLATEAU, SHOWING POLE-LIKE FORMS OF *FOUQUIERA COLUMNARIS* AND OTHER DESERT VEGETATION.

day we passed over the landscape shown in Plate 8 and crossed a low divide, where the "lost mountain" type of structure, already described, became first evident. The ground was covered with angular and sharply-rounded pebbles of acid and basic eruptive rocks, interspersed with thin crusts of lime carbonate, indicative of lake-bed deposits. A small outcrop of hard, compact, reddish quartzite was passed a few miles before San Juan de Dios, which place we reached about 3 p. m. on the 23d.

A little stream makes up out of the rocks in a canyon, flows a short distance, and sinks in the sand. Yet 'tis enough for human needs, and here in his adobe hut, thatched with palm leaves, lives a Mexican raising cattle and children (Plate 4). We are given a hearty welcome, and fed bountifully on stewed quail, beans, skim milk cheese, wild honey, and the leathery tortilla, made from corn crushed on the aboriginal metati.

The landscape here, except in the creek bottoms, retains its general desert aspects. The flora is composed of various species of cactus, among which the log-like cereus already mentioned is conspicuous. The *Fouquieria* and agave also abound. The large tree shown is a cottonwood, which I learned was not indigenous, but brought when a mere slip from San Diego, California.

The hill shown is composed at its base of compact brecciated quartz porphyry and diorite, capped by a light porous liparite. Small outcrops of black basalt occur well up the slopes, which are covered by boulders rounded and waterworn of liparite and andesite.

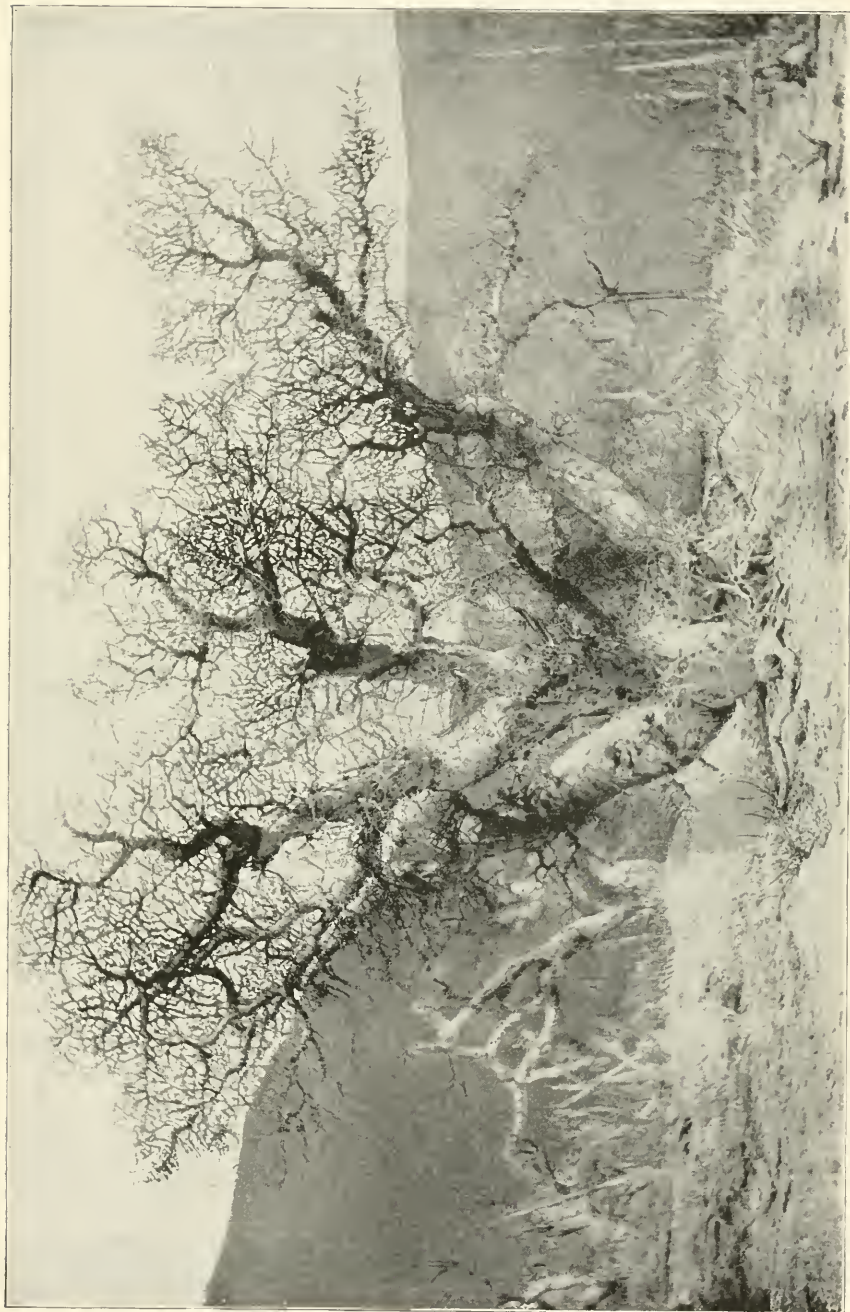
The following morning (July 24) a general round-up was held, and new animals obtained as far as possible, those obtained at Rosario being already footsore. As the distance to the next water was estimated at from 35 to 40 miles—a distance far too great for one day, over rough trails and with unshod animals—it was decided to delay our start until about noon, making a dry camp at night and finishing the trip the day following. This was the programme finally carried out.

The first few miles of the route lay upward through narrow canyons with steep, precipitous walls and loose, rocky bottoms, the slopes being covered with boulders of liparite, and the country rock consisting of a loosely consolidated and irregularly bedded coarse gravel and boulder aggregate cemented by fine sand. Finally, emerging from the canyon, or arroyo, we found ourselves on a high, level, liparite-topped plateau, which extends for miles in a northerly and westerly direction. The *Agave shawii*, with central stalk 10 to 15 feet in height, stand here by the tens of thousands in full bloom in the midst of piles of rocks so hot and forbidding that in spite of myself I drive by with scarcely a look. These continue abundant well over toward the east coast and are often beautifully symmetrical. For years these plants gather from the stingy soil the necessary nutriment for the flower stalk, storing it up in their thick, fleshy, bayonet-like leaves. When the season finally arrives,

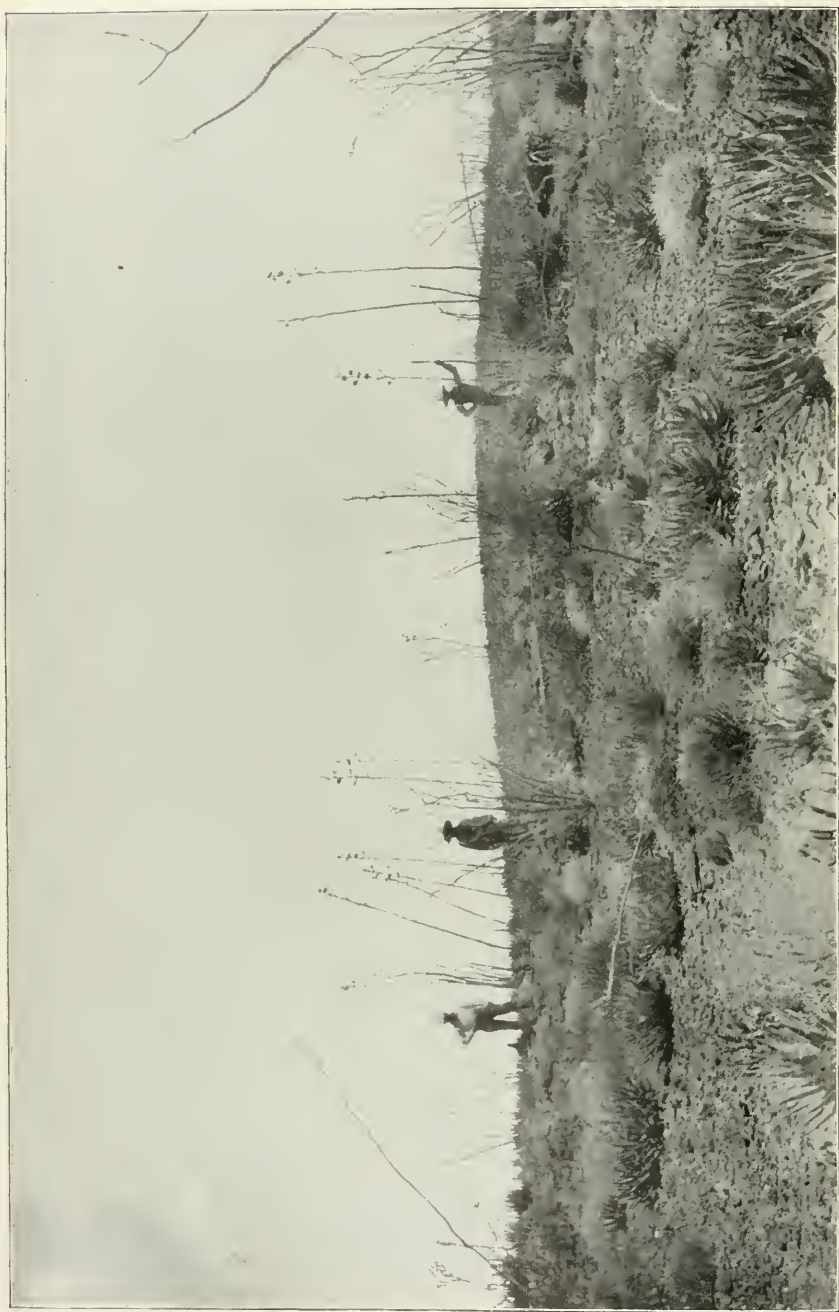
they shoot up in a surprisingly short space of time a single stalk, sometimes 10 feet in height and 4 inches in diameter at the base, bearing at the top a raceme of honey yellow, trumpet-shaped flowers. As the stalk shoots upward the leaves yield to it their stored-up juices, shrivel, and die. Thousands of these were passed during the day, in all stages of youth, maturity, and old age.

Continuing in a general easterly direction we soon reached the limit of the plateau and plunged, by means of steep and often dangerous trails, abruptly down several hundred feet where, for a distance of 20 miles or more, we traversed an undulating plain covered with sand and loose bowlders, some rounded and others sharply angular, with lake-bed exposures wherever the now dry water courses were cut to a sufficient depth. The few antelope seen at a distance were the only signs of animal life noted during the day. We camped that night (the 24th) in the sand of a dry, shallow water course, resuming our journey at 3.30 the next morning. Sharply-serrated mountain peaks, suggestive of volcanic cones, were seen in the distance, and about noon our plain ends in a precipitous canyon cutting across heavy bedded, dense, blue gray quartzites, which so strongly resemble limestones as to cause them to be mistaken for this rock until they came to be tested in the laboratory. In addition to this quartzite is a finely fissile, nearly black, mica-schist, both rocks standing nearly on edge and with a strike some 20° west of north and south. A dike of brecciated felsitic rock was also noted. As the disintegration here, as farther to the west, is mainly due to temperature changes, the schistose rocks weather into splintery forms and the general topographic features may be described as ragged in the extreme. The drainage from this point is toward the gulf, through ravines, arroyos, and canyons innumerable.

We find water and make our camp on the afternoon of the 25th in what is locally known as the Tule Arroyo, some 15 miles from the gulf coast. Two insignificant little springs bubble up here in the dry bed of the stream, furnishing, when first gathered, a pleasant sparkling fluid so highly charged with carbonic acid as to resemble the soda water of the drug stores. On standing, however, it soon lost its effervescent property and became so stale as to impart a decidedly disagreeable taste even to the coffee. Our first meal here consisted of stewed potatoes and dark heavy Mexican bread, as tough and indigestible as so much dried putty. Fortunately for us our Mexican guide went down the arroyo toward the gulf and returned before night with the carcasses of two mountain sheep, which kept us supplied with meat for the remainder of the trip, the atmosphere being so dry that there was no difficulty whatever in preserving it. The heat of the arroyo during the day was intense. The high walls on either hand afforded shade during the early morning and late afternoon, but during the middle portion of the day life was only rendered tolerable to those who stayed in camp by lying at full length in the sand under an immense mass of rock that had fallen from the cliffs above.



ELEPHANT WOOD (*Tetraclita entracensis*).



CHARACTERISTIC LANDSCAPE ON EASTERN SIDE OF PENINSULA NEAR THE TULE ARROYO.

The prevailing plants are the *Agave Schottii* and *Fouquieria splendens*.

Aside from the "tule," a flag which, from the shape of its leaf and the characteristic cylindrical spikelike form of its blossom and fruit, was assumed to be the common "cat tail" (*Typha latifolia*) of the Eastern States, and clusters of rushes, shown in the foreground of Plate 5, in the bottom of the arroyo, there were on the slopes above numerous cacti, one or more species of Spanish bayonet, the *Fouquieria splendens*, and numerous agaves. The most striking of the floral forms, and one which was seen here and only here, was the peculiar dwarf-like *Veatchia cedrocensis*, or elephant wood (Plate 9). These were rarely more than 10 feet in height, though sometimes a foot or more in diameter at the butt, and widely branching. Some of the smaller forms, but a foot or so in height, enlarged abruptly into bulb-like forms, 3 or 4 inches in diameter, on the immediate surface of the ground. The leaves and yellow blossoms are small and inconspicuous, and scarcely show at all in the rather poor photograph from which the accompanying engraving was made.

The water from the springs above mentioned flows into depressions in the rocky basin, forming pools, in which were found numerous water beetles and one hemiptera, similar, so far as the writer could judge, to the backswimming water boatman (*Notonecta*) of the Eastern ponds. The water itself is sufficiently charged with carbonate of lime to deposit a sinter on the surface over which it flows. During an earlier history these springs, issuing from near-by vents, have built up large dome-shaped masses of sinter, as shown in the left middle back group of Plate 5. Before the arroyo was cut to its present depth, springs were evidently more numerous, and tufa or travertine deposits of considerable extent are found upon the adjoining slopes. A large portion of this material is of a dull brownish gray color, slightly compacted, cellular, and of only geological interest. Occasional patches occur, however, of the same material of a white color, or beautifully tinted and veined with green and rose, and so compact as to acquire, in the hands of a workman, a surface and polish like glass. It is, in short, the onyx marble of commerce.¹

Monday, July 27, the work of inspecting the onyx quarries in the desert to the southeast having been completed, a start was made once more for Rosario, though over for the most part a somewhat different route. After leaving the canyon, or arroyo, and the rocky divide, our route lay over an undulating desert plain with flat-topped mesas on the southeast and mountain peaks visible on all sides. A portion of the plain was actually paved with basaltic fragments, though no basalt flow in place was observed. The onyx beds, noted above, lie in some cases like a pavement on the floor of the desert, the chief flora and general character of the landscape being as shown in Plate 10. At the end of the second day from the arroyo, i. e., Tuesday night, July 28, we

¹See the Onyx Marbles, their History, Origin, and Uses. Report U. S. National Museum. 1895, pp. 539-585.

camped at San Fernando, now represented only by the ruined mission and a few huts, occupied by Mexicans and their numerous progeny, while twice the number of dogs and a million times as many fleas served to fully sustain the national reputation.

The high mountain ridges at San Fernando are in part of compact greenish quartz porphyry, sometimes so jointed as to resemble stratified sedimentaries with gentle slopes toward the east and more precipitous toward the west. Passing, next morning, northward and eastward of San Fernando, the range from a slight distance shows highly tilted stratified beds, and the landscape, with its pole-like *Fouquiera*, is weird in the extreme, particularly about sundown. (See Plate 3.) For the remainder of the journey the route lay over a region essentially identical with that already described, San Quentin being reached early in the morning of July 31 in season to catch the fortnightly steamer for San Diego.