PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

THIRD SERIES.

GEOLOGY. VOL. I, NO. 2.

The Submerged Valleys of the Coast of California, U. S. A., and of Lower California, Mexico.

BY

GEORGE DAVIDSON, A. M., PH. D., SC. D.,

Member of the National Academy of Sciences, &c.

WITH NINE PLATES.

Issued June 26, 1897.

SAN FRANCISCO:

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I. THE EXTENT AND DIRECTION OF THE COAST NORTH OF LATITUDE 32° 32′.

THE general direction of the Pacific Coast of the United States from San Diego to the Strait of Fuca is as follows:

From San Diego, in latitude 32° 32′, longitude 117° 08′, to Point Arguello at the western entrance to the Santa Barbara Channel, in latitude 34° 34′, longitude 120° 38′, the coast runs nearly northwest by west for 225 miles; and off the northern part of this stretch lie the mountainous Santa Barbara islands. From Point Arguello to Cape Mendocino, in latitude 40° 26′, longitude 124° 22′, it runs northwest by north for 525 miles, and this stretch includes Monterey Bay, the Gulf of the Farallones, and Bodega Bay. From Cape Mendocino to Cape Flattery, in latitude 48° 23′, longitude 124° 44′, it runs north for 480 miles and is broken by the Columbia River and smaller rivers.

1. SAN DIEGO TO SANTA CRUZ.

In the region of San Diego, south and north, there are general depressions in the Coast Range of mountains; and the immediate seaboard is a terrace of 100 to 200 feet elevation, with hills rising to 1,000 feet in ten miles. The great plains of Los Angeles are thirty miles broad, and the Santa Clara River comes through a flat valley from ten to fifteen miles broad.

Abreast the Santa Barbara Channel the main shore is formed by the southern face of the high, abrupt range of Santa Ynez, which reaches 3,823 feet elevation in four and a half miles from the sea, and runs east and west. The Santa Monica is a parallel range a little to the south, ending

at Points Dumé and Mugu, but continued seaward through Anacapa, Santa Cruz, Santa Rosa, and San Miguel Islands.

North of Point Arguello are two or three valleys which lie between high ranges parallel to the Santa Ynez and which open directly upon the ocean.

Approaching San Luis Obispo Bay, where the Monte del Buchon is 1,830 feet high, the main range of the Coast mountains comes from the southeastward, reaches 4,000 feet elevation behind San Simeon Bay, and comes boldly upon the ocean a little north of Piedras Blancas, whence it runs to Carmel Bay for about 50 miles and forms the most compact and precipitous ocean barrier on the Pacific Coast. It reaches a culmination of 5,020 feet less than three miles from the sea, in latitude 36° 03′. Off this range the 2,000 fathom depth of the Pacific is only 52 miles from the shore.

At Monterey Bay there is a complete breaking down of the Coast Range for 25 miles, with the mountains receding well inland. Into this broad and deep bight heads the finest of the submerged valleys.

2. SANTA CRUZ TO CAPE MENDOCINO.

Northward of Monterey Bay, from Santa Cruz, in latitude 36° 57′, to the Golden Gate, in latitude 37° 48′, the great mountain ridge of the peninsula of San Francisco reaches 3,790 feet elevation, and offers an unbroken barrier along the ocean front for 50 miles, to the Golden Gate. This ridge is continued seaward, as shown by the submarine indications through the Farallones groups and the Cordell Bank.

The remarkable cleft in the Coast Ranges at the Golden Gate has no representative feature through the plateau of the Gulf of the Farallones. Just outside of this 100 fathom plateau commences the descent of the bottom to 2,000 fathoms, which depth is reached in 50 miles from the Southeast Farallon.

Part of the ocean barrier is continued outside of the spur of Mount Tamalpais (2,590 feet elevation), in a parallel

ridge of 1,350 feet, to the moderate ridge of Tomales Point (700 feet) and Bodega Head (241 feet).

Broad in from Bodega Bay, in latitude 38° 18′, with two esteros penetrating the tableland of 600 feet in height and the Russian River emptying into the ocean in latitude 38° 26′, there is a general break-down of the immediate Coast Range; but there are no seaward indications whatever of submerged valleys.

Northward of Bodega Head the coast mountains continue to the northwest in three or four parallel ranges or ridges, with a narrow plateau or terrace bordering the coast to and a little beyond Point Arena, in latitude 38° 57′. Thence to Cape Mendocino, in latitude 40° 26′, the coast mountains begin to rise abruptly from the ocean to 4,265 feet elevation, with no cross-cutting streams of importance, but with several moderately large streams running northwestward, parallel with the coast. There is one slight plateau projecting from the mountain flank at Point Delgada, in latitude 40° 01′. It is near the northwestern termination of this hundred miles of the Coast Ranges, where are clustered four very marked and deep submerged valleys.

3. Cape Mendocino to the Columbia River.

Northward of Cape Mendocino the Coast Ranges fall inland; they are not so high and compact as that to the southward, and are cut by many small streams fed by the heavy rains of the winter seasons. To the northward several large streams empty, and bays open upon the ocean, and miles of white sand dunes border the shore; but no indication of a submerged valley appears across the 100 fathom plateau; not even at the break-down of the range at and north of Crescent City Bay or off the Klamath River. These interrupted ranges towards the Columbia River reach 3,868 feet elevation at Mary's Peak, in latitude 44° 29′.

There is a general break-down of the ranges at the Columbia River, which discharges through a relatively low country. This great river does not come through a broad valley west

of the Cascade Mountains, but through a long gorge in the basalts, about six miles wide. This river drains a very extensive region, and it brings down immense deposits of detritus, which have formed a comparatively broad plateau of 28 miles within the 100-fathoms depth. In this plateau are evidences of a submerged valley, but further details are needed to determine its peculiarities.

4. COLUMBIA RIVER TO THE STRAIT OF FUCA.

Northward of the Columbia River the coast-line is in great measure low and backed by distant mountains, the outlying flanks of the Olympus mass.

Nearly halfway from Cape Disappointment (287 feet) these spurs gradually approach the shore until they reach Cape Flattery, with an elevation of about 1,500 feet. In this stretch of 125 miles of coast empty the waters of Willapa (formerly Shoalwater) and Gray's Bays, and two or three streams from large lakes inland: but there is no sign of a submerged valley abreast this low region. The soundings are relatively shoal for 20 miles off shore. That great inlet, the Strait of Fuca, opens upon the ocean in latitude 48° 23′–48° 31′, with the high island of Vancouver forming the north shore. The strait lies nearly east and west for eighty miles, with an average width of ten or twelve miles. It has an average depth of 100 fathoms in mid-channel, with 150 fathoms at the mouth, and a sharp turn to the southward parallel to the shore for some miles. It is the channel way for all the tidal waters of the far-stretching arms of Puget Sound on the south, and of Washington Sound and the Gulf of Georgia on the north.

II. THE ONE HUNDRED-FATHOM PLATEAU.

Off this long, bold coast thus briefly described, the waters of the Pacific reach a depth of 2,000 to 2,700 fathoms within as little as fifty miles off the mountain flanks. The descent to these profound depths is not uniform, however,

except off the face of the Sierra Santa Lucia. This deep plateau gradually shoals to the northward of Cape Mendocino, and 196 miles off the coast, between Cape Disappointment (46° 16′) and Cape Flattery (48° 24′), a depth of only 1,535 fathoms is reached. Generally there is a marginal plateau of ten miles width out to the 100 fathoms curve; and thence the descent is sharp to 500 and 1,000 fathoms. Only along a few parts of the coast does this 100-fathom plateau stretch out beyond ten miles, as follows:

The Coronados and San Diego Plateau. This comparatively broad plateau from the southward of Los Coronados Islands to Point La Jolla reaches out as much as fifteen miles, and the 30-fathom line marks the inner edge of muddy bottom.

The Gulf of the Farallones.—The off shore soundings from Point Cypress (latitude 36° 35′) to the Farallones (latitude 37° 43′), 82 miles, show that the 100-fathom plateau stretches off shore only five miles to the north of Point Pinos, and seven miles off El Jarro, west of Santa Cruz. Thence it increases to 14 miles in width off Año Nuevo, latitude 37° 06′, and runs northwest to five miles off the Southeast Farallon, where it is 32 miles from the Golden Gate. It continues northwestward 22 miles to and beyond the Cordell Bank, in latitude 38° 01′, and again approaches the coast under Fort Ross, latitude 38° 30′, where it is only eight miles wide.

The Humboldt Plateau. — There is a narrow plateau of eight miles northward of Cape Mendocino, off the low areas of the Humboldt Bay region. It continues thence to Point St. George, latitude 41° 50′, before reaching which it is 15 miles wide in latitude 41° 30′.

The Heceta Bank.—In the latitude of the Umpquah River, 43° 40′, this plateau of 100 fathoms lies ten miles off shore; thence it trends off shore quite rapidly until in latitude 44° 03′ it is 32 miles from the comparatively low shores; thence it uniformly moves shoreward until in latitude 44° 44′. It is about 12 miles off Cascade Head, in latitude 45° 03′, and continues so for some distance northward.

From the numerous streams and low-lying valleys that

mark this stretch of coast, there are no indications of submerged valleys in this extensive plateau.

The Columbia River Plateau.—From the latitude of Tillamook Head, latitude 45° 58′, the 100-fathom plateau of the Columbia gradually sweeps out to 28 miles in breadth off the mouth of the river, and then curves eastwardly toward Shoalwater Bay, in latitude 46° 43′.

III. SOME DEEP-SEA SOUNDINGS.

Before describing the submerged valleys, it may be well to notice a few of the deep-sea soundings in order to indicate the rapid descent to the profound depths of the Pacific plateau.

Off the coast of Lower California: 2,000 fathoms off Abreojos, in latitude 26° 45′.

Off the coast from Point La Jolla to Point Pinos:

1,000 fathoms at	37 miles	W. SW.	from San Diego.
1,900 "	" 128 "	W. by N.	" " "
1,674 "	" 34 "	SW.	" San Miguel Island.
2,000 "	" 35 "	W. by S.	" Point Conception.

At 615 miles W. by S. from Point Conception is the submarine mountain Belknap, which rises from 2,700 fathoms to 388 fathoms.

2,044 fathoms at	47 miles	SW.	from Cape San Martin.
2,000 "	" 57 "	SW. by W.	from The Sur.

In other words, the depth of 2,000 fathoms is reached at 50 miles broad off the Santa Lucia range, and Cone Peak of the outer range rises to 5,020 feet in 2¾ miles from the shore; thence northwardly the 2,000-fathom line trends off the coast, and is 95 miles W. ½ N. from Point Cypress. It then approaches the coast off the Gulf of the Farallones.

Outside of the 100-fathom plateau, as we approach the Gulf of the Farallones, the depth increases very sharply to 500 fathoms within two or three miles, and reaches 800 fathoms at 18 miles SW. from Santa Cruz; thence the slope is more gradual.

2,000 fathoms at 70 miles W. SW. from Pigeon Point.

It is curious that the Vitula shoal, upon which several vessels reported only five or six fathoms, was located near where this 2,000 fathoms depth was found.

2,000 fathoms at 50 miles W. SW. from Southeast Farrallon.

1,726 fathoms at 29 miles directly W. from Southeast Farallon.

And continuing northward we have:

2,000 fathoms at 54 miles directly W. from Fort Ross.
2,000 " " 71 " " " " " Point Arena.
2,000 " " 75 " W. SW. from Cape Mendocino.
1,700 " " 50 " W. from Trinidad Head (41° 03′).

A few soundings off and northwest from Cape Mendocino indicate a submarine prolongation of this range of mountains.

IV. THE SUBMERGED VALLEYS OF THE CALIFORNIA COAST.

The first discovery of a distinct valley in the submerged surface of the earth bordering the coast of California was made in 1855 by the U. S. Coast Survey. It is known as the Hueneme Submerged Valley. But as the operations of the Coast Survey did not contemplate the development of such physical characteristics, nothing further was done in subsequent surveys or studies. Later discoveries resulted merely from the hydrography necessary for navigation; but as the Santa Clara Valley opens directly upon the sea at the spreading of its fifteen mile low, flat debouchment between high mountains, it was thought that similar submerged valleys might be discovered off San Diego, San Pedro, Santa Monica, Monterey, and the Golden Gate. Certainly none were expected off Point Dumé, Carmel Bay, and the high, compact mountains south of Cape Mendocino.

All the submerged valleys so far developed lie south of

Cape Mendocino; and if attention be given to the orographical features of the coast, it will be seen that the Coast Ranges from the southward and southeastward seem to end abruptly upon the ocean front in latitude 40° 27′.

In October, 1886, the writer presented to the California Academy of Sciences some of the physical features of the submerged valleys under the high mountains immediately behind Capes Mendocino and Gorda, the more especially because the valleys lie nearly at right angles to the overhanging range. Subsequently he gathered all the data available for all the valleys, drew the contour lines to exhibit their peculiarities, and added memoranda of the character of the bottom and of the adjacent plateau. To the California series were added others partly developed by the U. S. Hydrographic Survey along the coast of Lower California. When the first short announcements of these valleys were made, they were known as "submarine valleys;" later they were designated "submerged."

The following is a condensed description of those submerged valleys, the characters of which appear in the contours thus drawn:—

1. THE SOLEDAD OR LA JOLLA VALLEY.

This valley heads southeastwardly into the slight recession of the shore-line on the north side of Point La Jolla. This point is the northern extremity of an almost isolated sandstone hill named Soledad, lying between the northern part of False Bay and La Jolla. The extent of the hill is about 3½ miles NW. and SE., and very nearly as wide E. NE. and W. NW. The ocean front is a three mile stretch of rocky, jagged shore, rising rather sharply to over 800 feet in one and one half miles. The higher part of the hill is to the W. NW. There is no very marked depression between this hill and the high land to the N. NE.; certainly nothing to indicate a submerged valley. The head of the valley is within one third of a mile of the deepest part of

the small cove, and carries 25 fathoms to within 150 yards of the three-fathom line. From its head it stretches three miles N. 40° W., to the 225-fathom curve, and then 2½ miles N. 70° W., to the 300-fathom curve, beyond which there are no immediate soundings. The valley is quite narrow out to the 200-fathom curve.

On the south side of the valley the 500-fathom line lies three miles broad off Point La Jolla, and thence the soundings deepen rapidly seaward, but to the southward the 50 fathom plateau increases in breadth to five miles off False Bay. North of the valley the 500-fathom line is barely two miles off shore and parallel therewith for 17 miles; outside this narrow plateau the water deepens rapidly to 200 fathoms. The greatest observed depth is 297 fathoms at 5⅔ miles from the beach, and about where the normal 120 fathom line would pass. Unfortunately the soundings are not numerous enough to afford much more information.

The fine dark gray sand of the bottom extends outward to about 25 fathoms. There is green mud and fine sand, with added broken shells, on the NE. and SW. slopes of the valley in 100 fathoms; at 150 fathoms, green mud alone. Approaching the head in 115 fathoms there is green mud and fine sand; and at the head in 25 fathoms hard bottom, which may be sand or rock.

The geographical position of the head of the valley at the 25-fathom curve is:

Latitude 32° 51¼′ N.; longitude 117° 16′ W.

2. The Carlsbad Submerged Valley.

One mile south of the town of Carlsbad the 50-fathom plateau is sharply indented by a broad valley 125 fathoms deep on that line. The 50-fathom curve is carried into the normal 25-fathom line; but at 200 fathoms the signs of a valley disappear. The geographical position is:

Latitude 33° 07½′ N., longitude 117° 21¼′ W.

The character of the country inside of the sea-coast plateau is irregularly rolling and reaches 2,000 feet elevation

in about 15 to 20 miles. There are three large streams coming from the San Luis Rey Mountains, with a general direction normal to the coast.

3. THE NEWPORT SUBMERGED VALLEY.

The high hills of 1,000 feet elevation westward of San Juan Capistrano, at the eastern approach to San Pedro Channel, break down almost completely in longitude 117° 53′ west, 22 miles east of San Pedro; and a large lagoon, now called Newport Bay, extends three or four miles inland, under the western flank of these hills.

There is deep water close to the shore, abreast the hills, 200 fathoms, within 3½ miles, as if a broad submerged valley were heading in toward the bay. A low, narrow, sandy peninsula extends nearly three miles in front of the bay, and at the western part of this peninsula a submerged valley reaches in close to the beach with 25 fathoms. It is well marked but not extensive, and reaches only to the 70-fathom line. West of it the broad 25-fathom plateau extends to San Pedro.

The geographical position of the head of this submerged valley is in latitude 34° 36¼′ N., longitude 117° 56′ W.

On the plateau inside of 25 fathoms, the bottom is fine gray sand, and occasionally mud; green mud and sand at 100 fathoms, and at greater depths brown mud.

A large wharf was built here under the writer's location, and this valley has protected it from storms for eight years.

4. SANTA MONICA BAY.

This broad bight or gulf is 25½ miles wide between Point Vincente at the E. SE., and Point Dumé at the W. NW., and ten miles deep at the town of Santa Monica, nearly equidistant from the two points.

The shores of this bight have marked characteristics. Point Vincente is the western rocky terminus of the isolated San Pedro Hill, 1,493 feet high, and well marked with old sea

terraces. Behind this hill for more than 20 miles to the north and east lie the great plains of Los Angeles, which drain into Santa Pedro Bay, but not into Santa Monica.

The northeastern shore of this bight for 15 miles is a sandy beach, with rolling, grass-covered sand-hills or ridges, reaching 200 feet above the sea. The northwestern shore is the western end of the Santa Monica Mountains, which reach over 3,400 feet elevation and come sharply to the coast-line, which is deeply cut by arroyos.

Three submerged valleys reach into this bight: two toward the plains, the third to the rocky head of Point Dumé, or rather to the mouth of the Cañada Zuma, 1½ miles west of Dumé.

5. The Redondo Submerged Valley.

From the deepest part of Santa Monica Bay the plateau of 50 fathoms extends seaward 10 miles, but at Point Vincente it is barely a mile off the rocky shore, and 400 fathoms is then reached in two miles, and very deep water fronts the south face of San Pedro Hill.

Through this plateau the Redondo submerged valley penetrates in a general E. NE. direction and heads six miles north of Point Vincente, somewhat transverse to the direction of San Pedro Hill, and two miles north of its NW. angle. It is a deep, narrow valley, 7½ miles long inside the general 100-fathom curve, and its greatest depth, so far as sounded, is 300 fathoms. It heads square on the beach towards the Redondo Hotel. The 25-fathom curve reaches within 200 yards of the beach and the 100-fathom curve is within 1½ miles. At the 225-fathom sounding the slope is 900 feet in 2600.

Throughout the valley the bottom is soft green mud, which reaches into 25 or 30 fathoms, when fine sand and gravel are found.

There are several curious features about this submerged valley: An oil well exists at the northern part in about 75 fathoms of water; and just north of the head, inside the

beach, is a salt pond, from which salt has been extracted for many years. The surface of this pond is ten feet below the surface of the bay.

The geographical position of the head of the valley is:

Latitude 34° 50⅛′ N., longitude 118° 23½′ W.

6. THE SANTA MONICA SUBMERGED VALLEY.

This valley is markedly different from that of Vincente or Redondo, 10 miles distant to the southeastward, with the 50-fathom plateau very pronounced between them. It lies nearly parallel with the former and heads towards the middle of the beach bounding the plains of Los Angeles. Unlike the Redondo, it drops from the plateau of 50 fathoms at 5⅔ miles from the beach, with a general direction west, and a slight curve of the axis to the north. It is very much larger than the Redondo. It reaches 260 fathoms in 11⅔ miles from the beach, with the 50-fathom curve 2⅔ miles to the E. SE. and 4½ miles to the north.

The floor of the plateau is fine gray sand to 25 or 30 fathoms. In 40 fathoms, near the outermost part of the 50-fathom plateau, gravel and broken shells in one place, but green mud thence to the greatest depths.

The geographical position of the head of the 50-fathom curve is:

Latitude 34° 54⅔′ N., longitude 118° 32⅔′ W.

7. THE POINT DUMÉ SUBMERGED VALLEY.

Point Dumé at the western boundary of Santa Monica Bay is a small dome-like termination of a lower projecting plateau from the southern base of the Santa Monica Mountains, which rise to 1826 feet in 2¾ miles, and to twice that height at their culmination. It is 202 feet above the sea, and one mile to the northwest from it, along the shore, opens a short, moderately broad, treeless valley, called the Cañada Zuma. East of Point Dumé the normal 25-fathom curve is 1½ miles off the shore; to the westward it is about one mile distant;

but it stretches close under and half a mile beyond Point Dumé, only 400 yards from the low cliffs, and forms the head of the submerged valley that runs out to the SE. by S., and drops off to 238 fathoms in 1¼ miles (1,428 in 6,600 feet), and less than a mile from Dumé. The distance between the 225 fathom curves at the deepest part is less than half a mile. Unfortunately there are no soundings beyond this. In fact there are so few soundings that the characteristics of the bottom have not been given; but on both sides we find gray sand at 25 fathoms, and green mud at 125 fathoms.

The geographical position of the head of the valley is: Latitude 35°, 00′ N.; longitude 118°, 49′ W.

8. The Point Mugu Submerged Valley.

This submerged valley lies at the eastern side of the Santa Clara Valley, near the eastern entrance to the Santa Barbara Channel. Fourteen miles west, northwest from Point Dumé, the mountain mass of Santa Monica terminates abruptly, dropping from 1,427 feet to the Laguna Mugu in less than a mile. Then the shore takes an outward, slightly convex curve for 15 or 16 miles, to San Buenaventura, with a low sand-shore immediately backed by an indurated sand that towards the west reaches 65 feet high as a steep cliff. This broad, flat, and slightly rising plain of the Santa Clara stretches many miles inland between high mountains, and through the western part of the valley runs the Santa Clara River. Where the plain meets the eastern mountain is the Laguna Mugu, with extensive marshes and a low, narrow sand beach, with a slight tidal opening as if the river may at one time have emptied here. Close upon this sand beach heads a double-armed, submerged valley, of which the details are readily given from the numerous soundings out to 500 fathoms.

The main axis of the Point Mugu Valley comes from about 475 fathoms at 11 miles SE. by S. from the head and

6½ miles from the rocky shore; runs parallel with the shore for five miles to a depth of 390 fathoms; then nearly north for four miles to 300 fathoms and curves to the NW. for three miles to 25 fathoms within a third of a mile of the receding beach. At the 275 fathom curve it gives off a branch towards the west for three miles to the 200 fathom curve, and then turns sharply to the north for three miles, ending with 25 fathoms about half a mile from the beach.

The eastern head is double and the innermost head is less than a third of a mile from the beach, and only 1¾ miles from the head of the western branch.

The fine gray sand is found out to 25 fathoms, and is mixed with mud to 50 fathoms; then green mud to 500 fathoms, except in one or two cases, when green mud and sand are given.

The geographical position of the eastern head of this valley is:

Latitude 35° 05⅔′ N.; longitude 119° 06′ W.

9. THE HUENEME SUBMERGED VALLEY.

As already mentioned, this valley heads close to the low shore of the broad Santa Clara Valley, eight miles west of Point Mugu, and nine miles east of San Buenaventura. It is therefore directly at the eastern entrance to the Santa Barbara Channel. The 25-fathom curve reaches so nearly to the beach that boats can land here when the surf along the other parts of the beach forbids an attempt at landing. The axis of the valley is nearly north and south, and is seven miles long to the 300 fathom curve. The valley is very narrow, averaging about a mile wide, and even the 25-fathom plateau on either side is sharply defined. It opens on the eastern prologation of the sharp ridge of Anacapa Island, which island, with Santa Cruz, Santa Rosa, and San Miguel is on the western prolongation of the well marked line of the Santa Monica range.

On both sides of the valley the bottom on the plateau at 15 fathoms is brown mud, a very unusual exhibition at that

small depth. In the deeper parts the bottom is dark green mud. At the mouth of the valley the 120-fathom curve stretches two or three miles into the Santa Barbara Channel.

This valley, with the two off Point Mugu, within seven miles to the eastward, is at the mouth of the Santa Clara Valley.

The 25-fathom plateau is very broad, stretching 7½ miles broad off San Buenaventura.

The geographical position of the head of the valley is: Latitude, 34° 09′ north; longitude, 119° 13′ west.

10. THE SANTA BARBARA CHANNEL.

This channel is one of the principal features of the coast of both Lower and Upper California and is not duplicated on the Pacific Coast. It is formed by the islands stretching westward on the prolongation of the Santa Monica Mountains on the south, and the mountain barrier of the Santa Ynez Mountains, whose base forms the north shore. The islands lie nearly parallel with the main land for sixty miles, at an average distance of a little more than twenty miles. The Santa Ynez Mountains reach 3,960 feet elevation five miles behind the town of Santa Barbara, and east of the Rincon they are 2,000 feet high within a mile of the shore. The islands are mountainous and reach 980 feet elevation on Anacapa, 2,400 feet on Santa Cruz, 1,586 feet on Santa Rosa, and 861 feet on San Miguel.

The bottom of the channel reaches a depth of 341 fathoms and exhibits no abrupt contours. The western entrance shows 230 fathoms in mid-channel. Under the northern shore the bottom is soft green mud to the depths; under the island shore the mud is mixed with sand and broken shells to about 40 fathoms.

Off the northwest part of San Miguel Island the surface of the water inside 25 fathoms shows the existence of a submarine oil well.

11. THE SANTA CATALINA SUBMERGED VALLEY.

Although the great island of Santa Catalina reaches 2,110 feet elevation, and is cut near its western quarter by the "great depression" nearly to the water, yet there are some slight signs of a submerged valley on each side, pointing to this depression. Deep water surrounds the island, the 100-fathom curve lying 1½ miles from shore and being slightly closer to the northern shore than to the southern.

The island, which is 18 miles long, is traversed east and west by a great rocky ridge, whose crest keeps within 1½ miles of the north shore. On the south side of this crest-line, and on the larger part of the island, converging ridges reach generally westward to a marked indentation in the precipitous shore-line, and into this rock-bound cove the head of a submerged valley intrudes, bringing the 25-fathom curve within one third of a mile of the general curve of the shore, and the 300-fathom line within $3\frac{4}{5}$ miles. On the southeast side of this valley the 75-fathom plateau reaches out 3⅓ miles.

At 25 fathoms the bottom is fine sand; at 40 fathoms and over, gray mud; green mud is found at 100 fathoms and more.

The geographical position of the head of the valley is:

Latitude 33° 23′ N., longitude 118° 29′ W., and its general direction seaward is west.

There is no break in the uniform bottom between Anacapa and Santa Cruz Islands.

12. THE SANTA CRUZ ISLAND SUBMERGED VALLEY.

The crest-line of the principal east and west axis of this island, which is 21 miles long, reaches an elevation of 2,150 feet. The southern parallel ridge reaches less than 1,500 feet; off this south shore the soundings drop to 600 fathoms in less than three miles.

The channel between the islands of Santa Cruz and Santa Rosa of the Santa Barbara group is nearly five miles wide,

with the depth of 25 fathoms and less over the greater part, as in the Anacapa and San Miguel passages. But into the southern entrance of this channel a very marked submerged valley intrudes, carrying the 100-fathom curve into the 25-fathom plateau, while depths of 400 fathoms are shown in two arms coming in from the E. SE.

The general direction of the valley is parallel with the southwest shore of Santa Cruz Island and is less than two miles therefrom. The general direction is W. NW. (the head) and E. SE. The plateau of 50 fathoms on the Santa Rosa side is out as far as the 400-fathom curve of the valley.

The bottom is fine gray sand out to 40 fathoms; and green mud in greater depths, except gravel and broken shells in one sounding near the 200-fathom line. The geographical position of the head of the valley in 25 fathoms is:

Latitude 34° 00′ N., longitude 119° 56′ W.

13. NORTHWARD OF CAPE CONCEPTION.

North of Point Arguello for some miles the mountain ranges lie parallel with the Santa Ynez range, and the streams run through the intervening valleys to the ocean. The 100-fathom plateau is narrow, yet there are no indications of any submerged valley breaking through it.

14. THE SIERRA SANTA LUCIA.

This mountain range presents the most compact and precipitous ocean barrier on this coast. It extends through one degree of latitude NW., from the cañon of San Carpóforo to Point Pinos in 36° 38′. Midway it is accentuated by the Twin Peaks that reach 5,020 feet elevation only 2¾ miles from the sea, and carries its height well to Point Sur, close behind which rises Carmel Peak to 4,417 feet. This crest-line is the outer of two parallel ranges, hardly ten miles apart; the inner reaches 6,000 feet elevation east of the

Twin Peaks. East of the inner range is the valley of the Salinas River. Off the base of this range the 100-fathom curve lies but one to three miles out, and the descent thence to 1,000 fathoms is sharp, while 2,000 fathoms is reached at 50 miles.

There are two slight indications of submerged valleys in the face of this barrier: One is faintly indicated six miles NW. of Cape San Martin, in latitude 35° 57′, heading directly into the cove under the Twin Peaks, where the 200-fathom curve reaches across the normal 100-fathom line. The second, recently developed, is more marked. It runs sharply through the 100-fathom curve, and the 25-fathom curve reaches almost to the cliffs in latitude 36° 12′, where the crest-line of the Sierra reaches 2,900 feet elevation only 1½ miles from the shore.

There is no particularly marked cañada near its head. The valley opens to the SE., parallel with the cliff-line for nearly a mile, and then bends to the S. SE. to the 200-fathom curve in less than a mile, and only $1\frac{1}{10}$ miles from the shore. The 200-fathom line is just inside the normal 100-fathom line. Near the head 94 fathoms are found one third of a mile off the cliffs.

15. THE CARMEL SUBMERGED VALLEY.

Near the northern extremity of the Santa Lucia range, and six miles south of Point Pinos, the mountains break down suddenly, and the Carmel River empties into the small cove called Carmel Bay. It is an indentation 1½ miles deep toward the east, with a breadth of three miles NW. and SE.

The submarine valley comes from the profound depth of 540 fathoms, only three miles SW. of Point Cypress, and heads to the SE., running four miles to within a mile of the shore. At 300 fathoms depth another arm heads nearly east for three miles into the southeast angle of Carmel Cove, where the 25-fathom curve is close to the shore, at the opening of a deep, narrow cañon from the mountains, which

are here 1,000 feet high. A third branch heads into the northeast angle of the bay, but the 25-fathom curve reaches in only half a mile from the shore. Between these two heads enters the Carmel River from the SE., but it is too weak and insignificant to suggest the submerged valley.

The few characteristic specimens of the bottom show green mud and sand at 100 fathoms on the south plateau; fine green mud and mica on the north plateau, and green mud, sand and mica at 475 fathoms.

Northward of Point Cypress the soundings decrease, and from Point Pinos the plateau of Monterey Bay stretches for thirty miles to the NW.

The latest soundings with the dredge show boulders under the soft muddy bottom at 480 fathoms off Point Pinos.

16. THE MONTEREY PLATEAU AND SUBMERGED VALLEY.

Monterey Bay is a great bight or gulf extending about 15 miles inside the general trend of the coast, and is about 23 miles wide.

From the general conditions of the San Francisco plateau to the northward, and the low country to the eastward, we would naturally expect the 100-fathom plateau to occupy the whole of the gulf or bay. Nevertheless, a remarkable submerged valley, similar to that of Point Hueneme, runs across this plateau and heads into a low-lying country immediately behind the 30 miles of shore-line of Monterey Bay. It reaches into the middle of this low line of beach near the mouth of the Salinas River, and the 50-fathom line is within less than half a mile of the shore.

The valley, which runs east and west, is narrow, and at seven miles from the shore the 100-fathom curves are only two miles apart and the depth 350 fathoms where the 50-fathom would be normal. It broadens, and at 11 miles has a depth of 615 fathoms. From its nothern edge a short, deep valley reaches to the northeast, but the 50-fathom curve of this arm is five miles from the shore.

The characteristic soundings adjacent to this valley are

fine soft mud, dark gray, dark yellow, and dark green, as far in as 30 fathoms of water, with occasional cases of fine dark sand, even to 150 fathoms.

Near the head of this valley empties the Salinas River from the southeast, and the Pajaro from the northeast. One or two miles inside the shore, at the head of this valley, are some very deep, fresh water lakes, but we have no certified measurements of their areas or depths. The peculiarities of the Salinas will be described in another paper.

Transpacific Cable.—The existence of this submerged valley of Monterey has been taken advantage of to propose it as the shore approach for a transpacific cable, and a line of soundings was run through it by Capt. Tanner, of the U. S. S. "Albatross," who developed a depth of 868 fathoms on the line of its axis at 16½ miles from shore. The conditions are very favorable for an undisturbed bed up to the very shore of the bay.

17. The Coast North of Monterey Bay.

Northward of Monterey Bay there are several well marked breaks in the Coast Ranges, viz.:—

At the Golden Gate, at Bodega Bay, and thence to Russian River; and yet off none of these breaks is there the least sign of a submerged valley in the plateau out to 100 fathoms.

Northward of Russian River the Coast Ranges are quite compact and the elevation of the crest-line from 2,000 to 2,500 feet to Point Arena, in latitude 38° 56′.

The Walalla River breaks squarely through the outer range in latitude 38°, but there is no sign of a submerged valley off its mouth.

On the north side of Point Arena there is a receding of the shore-line for a mile or two and low country inside, but no sign of cutting through the 100-fathom plateau; thence northward the mountains increase in elevation to Cape Mendocino, where they reach 3,400 feet, with a sharp, well marked crest-line, culminating at 4,265 feet at King Peak.

Five or six miles inside this shore-line and parallel therewith the Mattole River runs to the northward and empties into the ocean two miles north of Punta Gorda; and 20 to 25 miles further inland and parallel with the shore flows the Eel River from the southeastward, through a deep valley that opens on the coast in latitude 40° 40′ just south of Humboldt Bay. The outer of these two parallel ranges rises to an elevation of 4,265 feet in latitude 40° 09′, only 2½ miles from the shore. Under the highest parts of this ocean barrier, within a distance of 20 miles along the shore, head four deep submerged valleys, between latitude 40° 06½′ and latitude 40° 23′.

The details of this part of the coast are as follows:—

18. The King Peak Submerged Valley.

A submarine ridge named the Tolo Bank runs southward from Point Delgada at Shelter Cove, in latitude 40° 01′, for ten miles or more. It has as little as seven fathoms of water upon it, and the tail of the 15-fathom curve lies five miles off shore. The depth of the marginal plateau at 100 fathoms is eight miles from shore. Just north of this bank, off Shelter Cove, there has been developed a deep, submerged valley, where it breaks through the marginal plateau and runs sharply into the immediate coast-line under the culminating point of the crest-line of the coast mountains. The head of this submerged valley is 100 fathoms deep at half a mile from the shore, and the depth of 25 fathoms almost reaches the rocks under the cliffs. The 100-fathom line of the plateau lies six miles off Point Delgada, and where this valley breaks through it the depth reaches more than 430 fathoms. The slopes of the sides of this valley are quite steep; in places the bottom drops 100 fathoms in a quarter of a mile. The general direction of the valley, which is nearly straight and parallel with the Tolo Bank, is S. SW., and its length to 450 fathoms is seven and a half miles. The bottom of the plateau is fine gray sand out to 45 fathoms, and in two or more points on the north plateau

to 75 fathoms. At greater depths the bottom is green mud, and blue mud at some soundings on the north plateau.

The mountain toward which this valley heads is King Peak, 4,265 feet high, and only two and a half miles inside the shore. The topography indicates no break in the compact rocky coast-line, although there are numerous short gulches, as in adjacent parts of the coast.

The 25-fathom head of the valley is in latitude 40° 06½′ north, longitude 124° 08′ west.

19. THE SPANISH FLAT SUBMERGED VALLEY.

This is the second of the four submerged valleys between Point Delgada and Cape Mendocino. It is only six miles northwestward of the King Peak submerged valley. We find that the 100-fathom plateau has decreased in width to a scant five miles, and the head of the valley does not reach nearer than one and three-fourths miles from the cliffs; nevertheless, it is deep and sharply defined, and has the same general direction as the King Peak; that is, northeast and southwest. Its length as exposed is nearly five miles, because the soundings reach out only to 337 fathoms. The 300-fathom curve reaches into the line of the normal 100-fathom curve and the sides have steep slopes. It heads towards the compact bold coast-line near Spanish Flat, behind which low, narrow strip the mountains rise to about 3,000 feet in two miles. The plateau has a bottom of fine gray sand to 50 fathoms, with blue and black mud on the margins of the valley; generally green mud soundings and one "rocky" in the depths.

The geographical position of the head of the valley at 25 fathoms is:

Latitude 40° 10′ north, longitude 124° 15½′ west.

20. THE PUNTA GORDA OR MATTOLE SUBMERGED VALLEY.

Punta Gorda, in latitude 40° 15½′ north, is the bold and abrupt termination of the high, narrow mountainous ridge

that comes from the southeast and separates the valley of the Mattole River from the ocean by a width of only six miles. The Mattole runs northwestward through the mountains and breaks through the high and apparently continuous mass two and a half miles northeast from Point Gorda and ten miles south of Cape Mendocino. The 100-fathom plateau reaches out six miles from the point, with indications of a drop to 600 fathoms within the next mile. At six miles from the shore a deep submerged valley of more than 520 fathoms breaks through the 100-fathom plateau.

The 25-fathom head of this valley reaches within a quarter of a mile of the shore, and about one and a quarter miles northeast of the mouth of the Mattole. Its general direction seaward is W. SW. Out to the 300-fathom depth the direction is about SW. by W. for three and one third miles, and then west to 731 fathoms. The depth of 100 fathoms in the valley is only one and a half miles from the shore, and the sides of the valley are remarkably steep. The 100-fathom curve of the valley comes close between the general 30-fathom curves of the plateau north and south, where they are only one third of a mile apart. The bottom of the 100-fathom plateau out to 50 fathoms is varied: fine gray sand, green mud, gravel, and broken shells. In the submerged valley it is green mud only in spots, the principal soundings being "gray sand" and "rocky" out to 730 fathoms—features shown in no other submerged valley.

This valley heads into the high mountain mass, but the mouth of the Mattole, one and a quarter miles to the SW., opens upon the ocean through a valley about half a mile in width, after a course of three miles from the eastward. It heads close behind the hills of Point Delgada. This stream does not carry much water in the dry season when the mouth is sometimes closed by the sand which is moved northward by the Davidson inshore eddy current.

The geographical position of the head of this submerged valley is:

Latitude 40° 18½′ north, longitude 124° 21′ west.

21. THE CAPE MENDOCINO SUBMERGED VALLEY.

This is the fourth and northernmost of the Mendocino series. The distance between Point Gorda and Cape Mendocino is 12 miles, with a very slight recession of the intervening shore-line to the eastward. The mountains come to within three miles of the ocean, with a height of 2,600 feet; at ten miles inshore they reach 3,400 feet.

We have shown that the Mattole or Punta Gorda submerged valley lies just north of that point; and yet within four miles of it to the northward enters the northenmost of this group of remarkable submerged cañons. This fourth valley lies under the southern edge of the relatively broad plateau that makes out six miles to the westward of Cape Mendocino, with only 55 fathoms. More detailed soundings have not been made. On the line of this 55 fathoms the valley has a depth of 500 fathoms and heads in nearly east to 25 fathoms about 1½ miles from the shore. It has steep sides; and in one place, on the north side, the drop is 250 fathoms or 1,500 feet in half a mile. As in the other three valleys, the bottom on the adjacent plateau has many points of green or black mud as far in as 25 fathoms. The valley itself has green mud, and yet in two places at depths of 320 fathoms broken shells were brought up with gravel. Both slopes of the valley have green mud up to 30 or 35 fathoms, when the bottom changes to fine gray sand.

The geographical position of the head of this valley in 25 fathoms is:

Latitude 40° 23′ north; longitude 124° 24′ west.

Northward of this valley the irregular and comparatively shoal bottom off Cape Mendocino, marked by Blunt's Reef and other dangers, stretches out well to the westward of the usual coast depths, and is thence spread out towards Humboldt Bay and Trinidad Head as a broad plateau inside the 100-fathom line.

The occurrence of these four characteristic submerged valleys within a lineal coast-line of 22 miles is remarkable. Cape Mendocino and the adjacent high coast is the

termination of the Coast Range of mountains coming from the south-east and forming the great ocean barrier. This range is, however, divided lengthwise by two valleys, each carrying a stream that rises in the southeast. These streams run nearly parallel with the coast-line. The western stream is the Mattole River and the eastern is the Eel River, with two principal forks. The former rises in latitude 39° 55′, and averages six miles only from the coast, and the latter rises in latitude 39° 17′, longitude 123° 20′, and averages 25 miles from the coast.

We have stated that the Mattole empties near the head of the Mattole submerged valley; the Eel River empties through a broad, beautiful, low-lying valley, 13 miles northward of Cape Mendocino, but there is no indication of a submerged valley at its debouchment.

The high terminal of this part of the Coast Ranges embraces Punta Gorda, Cape Mendocino, and False Cape, or Cape Fortunas. Signs of their extension are shown by the soundings to the northwestward, where submarine peaks rise above the general plateau of the Pacific; and it is a curious fact that all the recorded submarine earthquakes along the Pacific Coast of the United States have been felt off Cape Mendocino.

Within 50 miles northward of Eel River empty the Mad and Klamath Rivers. The great southern fork of this river is the Trinity, running parallel with the general trend of the coast south of Mendocino; but there are not the slightest indications of submerged valleys off their mouths.

Practical Bearing of these Northern Submerged Valleys.— Two problems are at once suggested by these four submarine valleys; one is eminently practical: Steam-coasting vessels bound for Humboldt Bay, when they get as far northward as Shelter Cove, haul into the shore to find soundings and then continue their course parallel to the shore. One vessel has been lost by failing to find bottom until close upon the rocky coast, and blame was attached to the captain. This steamer doubtless sounded up the axis of

the King Peak submerged valley and necessarily found no bottom with the ordinary lead line. She would run into danger between casts that were deluding. Had the existence of this valley been known at that time, the vessel would have proceeded in a different and more guarded manner.

The second bearing which these great submarine valleys have is upon the deep sea fauna which must be brought close under the shores. They carry in the colder waters coming from the north and outside of the influence of the close inshore eddy current setting to the northward.

In 1870 the writer was becalmed off Cape Mendocino for five days, in clear weather, and had a capital opportunity of determining the breadth and velocity of this Davidson eddy current, acting under the most favorable conditions, for the favorable weather had lasted through two previous days. The outer edge of the current was well marked at 15 miles off the capes and was running about one and a half miles per hour to the northward.

V. LOWER CALIFORNIA, MEXICO.

We have first described the submerged valleys of the coast of California because they are somewhat more familiar to the hydrographer and to the navigator, and more especially interesting to the geologists who are acquainted with the geology of our seaboard.

We now describe the submerged valleys of part of the Pacific Coast of Lower California, which are less known to the hydrographer and navigator, and of which the surroundings are less known to the geologist.

1. GENERAL FEATURES OF THE PENINSULA.

The principal orographical feature of the peninsula of Lower California is the great mountain chain throughout its length from latitude 23 . The mountains reach an

elevation of 10,000 feet and there are a few passes across the peninsula. Along the Pacific front the coast is much broken, rocky, and mountainous, reaching elevations of over 3,000 feet in less than five miles. A series of islands and rocks about 150 miles off shore and parallel with the peninsula would appear to indicate a submarine range of mountains, with profound depths between them, and hence to the coast.

2. THE ONE HUNDRED-FATHOM PLATEAU.

Along the whole line of the Pacific Coast of Lower California, 700 miles, the 100-fathom plateau is found in but few places. For example, from Cape Lazaro in latitude 24° 45′ to Abreojos Point in latitude 26° 45′ (130 miles NW.), under the broad indentation of this shore, the plateau of 100 fathoms stretches out 35 to 40 miles without the sign of a submerged valley through it. At the southeastern part of this plateau the prolongation of the mountainous island of Santa Margarita and Point Lazaro is clearly indicated for 75 miles to the northwest. At the northwestern part the depth drops to 2,000 fathoms only 30 miles from the plateau.

There is another 100-fathom plateau inside of Cerros Island, latitude 28° 15′, covering the whole of the Sebastian Vizcaino Bay, 60 miles wide to the 100-fathom line. Twenty miles outside of San Benito Island (close to Cerros) the depth is 1,300 fathoms. This great bay reaches in well to the southeast and is bordered by low sand dunes and great lagoons, behind which the mountains retreat far inland; yet there is no indication of any submerged valley across the 100-fathom plateau.

From the northern part of this bay to Cape San Quentin, in latitude 30° 20′, the 100-fathom plateau approaches the steep coast-line within six or seven miles.

3. THE SAN PABLO SUBMERGED VALLEY.

Point San Pablo lies in latitude 27° 13′ and is one of the prominent headlands along the west coast, projecting beyond

the general line of the coast, It is a high, rocky cliff, backed by a cluster of hills, which reach 1,800 feet elevation in two or three miles. Seven miles to the northward a deep, narrow cañon breaks upon the low shore; but there are no indications of a submerged valley off it.

The submerged valley heads close under the west side of the cliffs forming the point and is parallel with them. The 50-fathom curve reaches 1½ miles north of the point and 1¼ miles broad off the shore. From this head the valley runs to the south 2¼ miles to the 200-fathom curve, then gently curves to the southwestward to 358 fathoms in a total distance of 4¾ miles. It is comparatively narrow.

The 100-fathom plateau lies eight miles from the north shore of the point and about the same distance to the south of that point. The 358-fathom sounding lies on the normal line of the 55-fathom curve of the 100-fathom plateau.

The character of the bottom in the valley is not noted; but "rocky" and "fine sand" are given on the north plateau, and fine sand on the south.

The soundings are not carried beyond the 358 fathoms, but at 28 miles S. 20° W. from the point one depth is given at 2,155 fathoms. There are no topographical features of the coast which would suggest this submarine valley.

4. THE TODOS SANTOS SUBMERGED VALLEYS.

For a distance of 30 miles (from latitude 31° 30′ to latitude 32° 00′) the normal 100-fathom line is intruded by irregular depths of 500 fathoms. One broad submerged valley, 370 to 50 fathoms deep, stretches in six or seven miles to the southeast into Soledad Bay, at 31° 35′ latitude. The submarine projection of Santo Tomas Point, which forms the southwest side of Soledad Bay, stretches out seven and one half miles, with only 50 fathoms of water; this forms the south side of the submerged valley.

A narrow submerged valley passes between Point Banda (31° 45′) and the Todos Santos Islands, and carries 200 fathoms at the gorge-like entrance. Inside the bay or gulf

of Todos Santos it expands to the 40-fathom curve. Point Banda lies 12 miles N. NW. from Point Santo Tomas.

In latitude 31° 55′ a third broad but not important submerged valley points to the east, just north of Point San Miguel, and forms part of San Miguel Bay.

It is to be noted of these three submerged valleys that the 100 and 200-fathom curves follow generally the conformation of the coast, which is quite high and precipitous, and reaches 3,347 feet elevation in two and three-fourths miles. The exception to this characteristic coast-line is in the southeastern part of the Todos Santos Bay, which is the low opening of a broad valley draining to the northwest. This low shore and valley decrease in width inland.

THE SUBMERGED VALLEY OF DESCANSO BAY.

There is clearly indicated a submarine ridge running northwest and southeast through the Coronados Islands, about seven or eight miles offshore and parallel with it. It reaches from latitude 32° 03′ to the Coronados, latitude 32° 41′. Inside of the southern point of this ridge, 7½ miles off Point Sal si Puedes, and carrying from 15 to 60 fathoms of water, there enters from the southward a broad valley, two to five miles wide, with 425 fathoms. It reaches 50 fathoms ten miles to the northward, under Point Descanso.

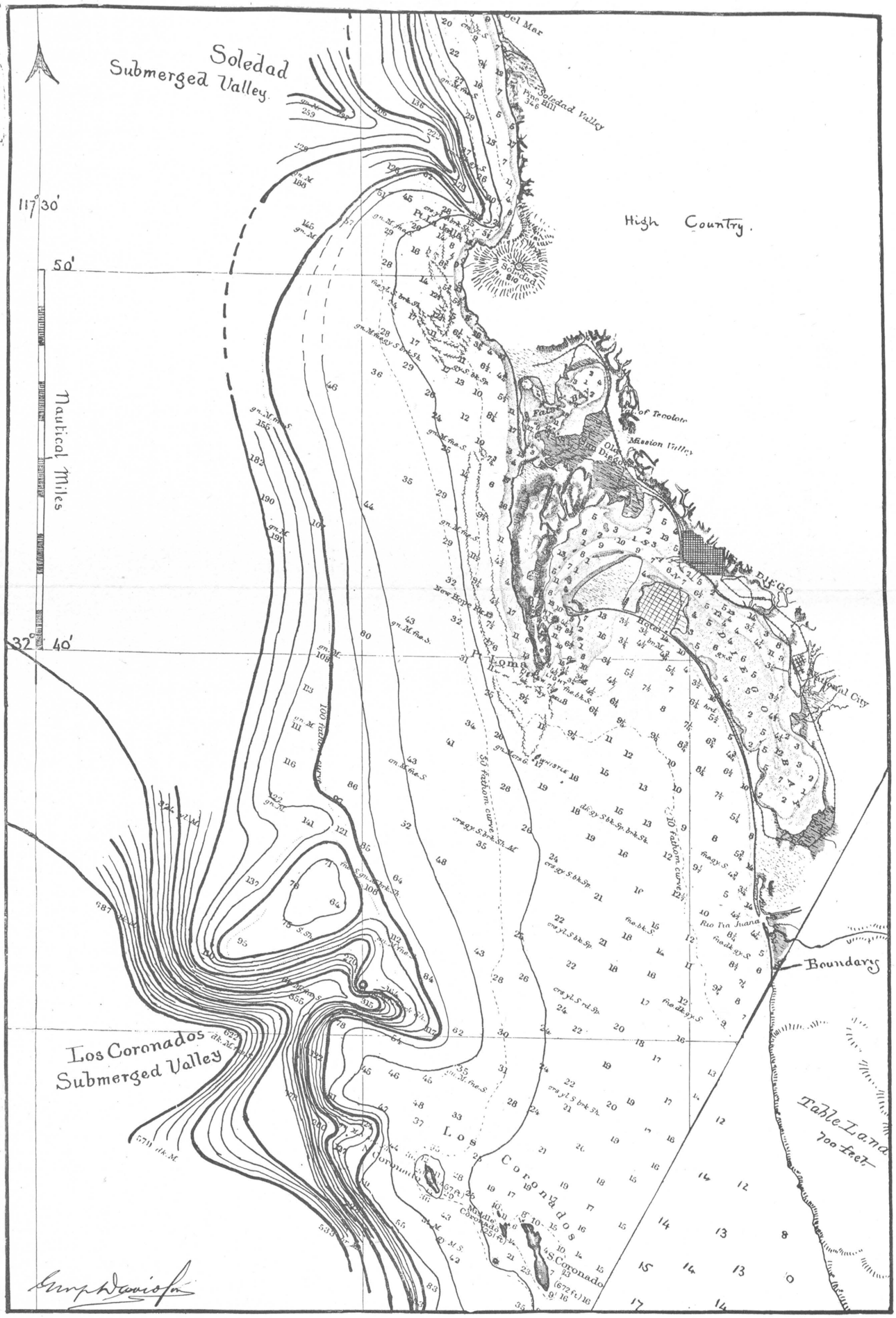
The soundings show green mud at two points north and south in this valley; land and shells on the outer ridge in 30 to 60 fathoms. Three and a half miles outside the 100 fathom plateau, in latitude 32° 18′, the depth reaches 773 fathoms.

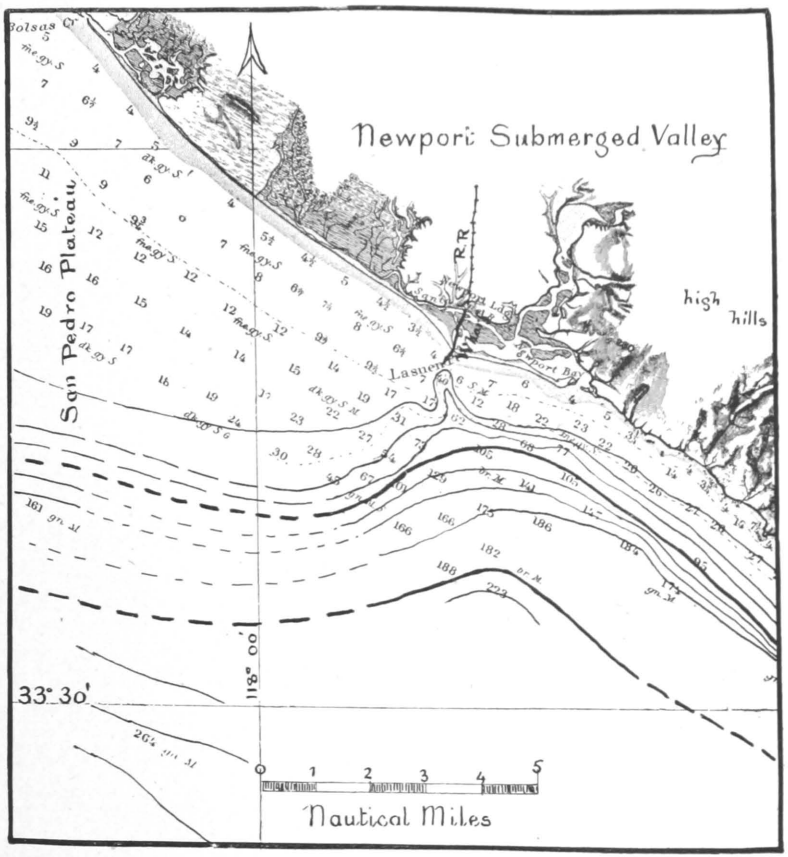
6. THE SUBMERGED VALLEY OF LOS CORONADOS ISLANDS.

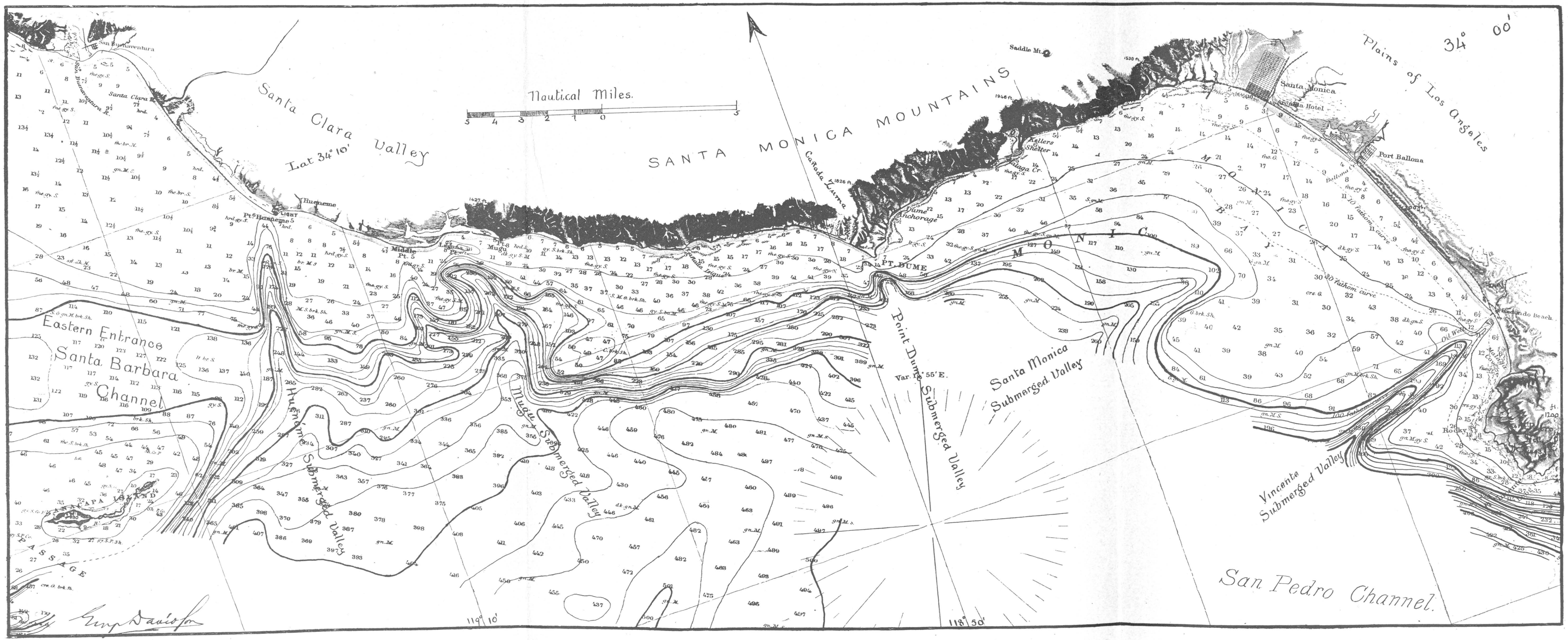
This is a deep, sharp valley penetrating the northern part of the San Diego or Coronado plateau from a depth of 622 fathoms to 50 fathoms in seven miles. Its general direction

is east, and the head is three miles north of the northern island, and seven miles from the shore, which is a low terrace under high mountains. The soundings are too few for minute illustration or description, but between two soundings of 75 fathoms, one mile apart, north and south of each other, the valley is 315 fathoms deep. This gives slopes of 1,440 feet in 3,000 feet, or about twice as steep as the heaviest grades of the streets of San Francisco.

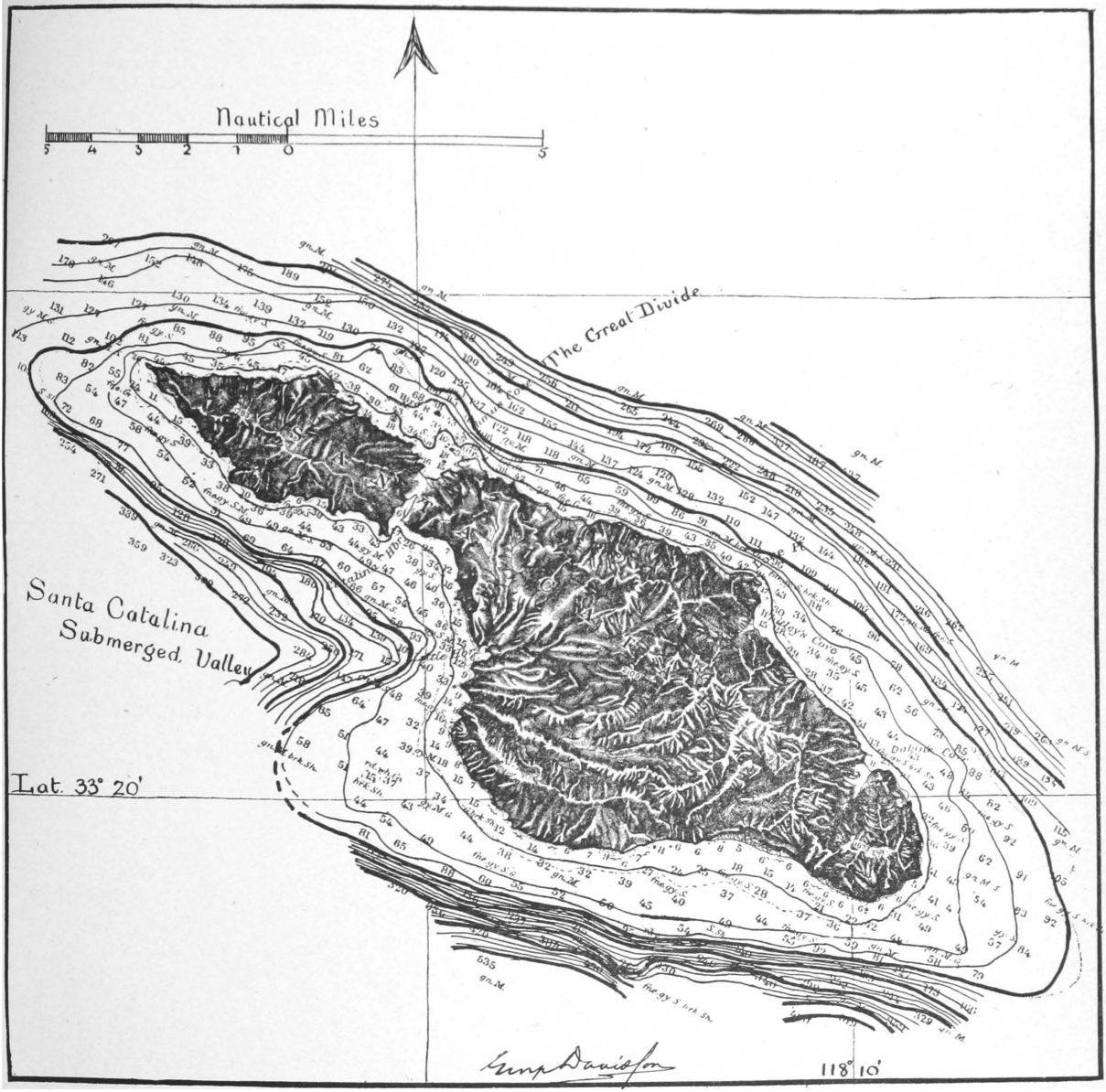
The bottom is generally soft mud to 40 fathoms, although there is occasionally sand as deep as 600 fathoms. Gray sand and shells mark the bottom inside of 40 fathoms.

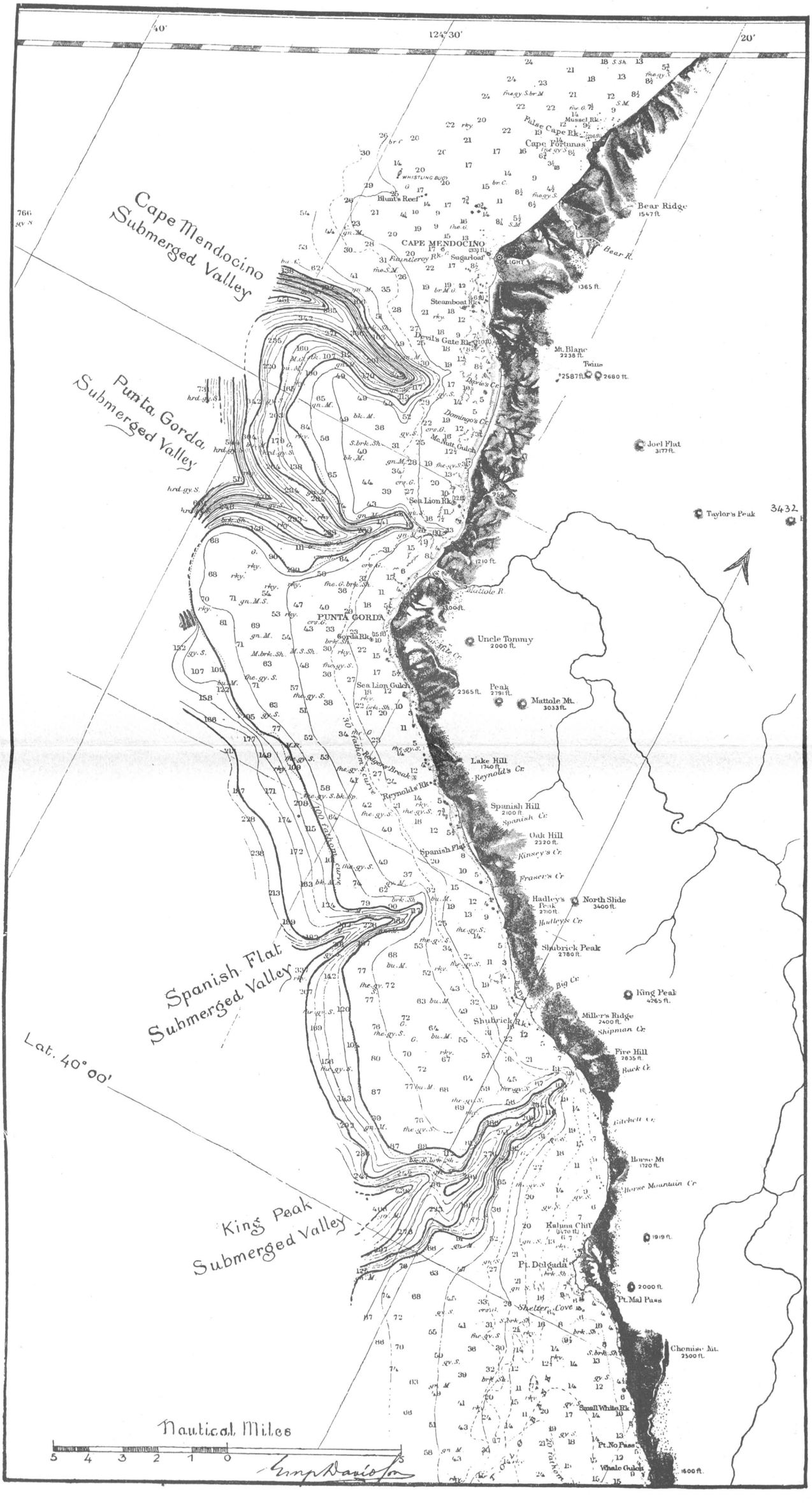

Soledad
Submerged Valley.
Del Mar
Soledad Valley
117° 30'
50'
High Country.
Nautical Miles
32° 40'
Mission Valley
San Diego
Point Loma
National City
Boundary
Los Coronados
Submerged Valley
Table Land
700 Feet
Los Coronados
N. Coronado
S. Coronado


Newport Submerged Valley
San Pedro Plateau
high hills
Lasuen
R.R.
118° 00'
33° 30'
0 1 2 3 4 5
Nautical Miles

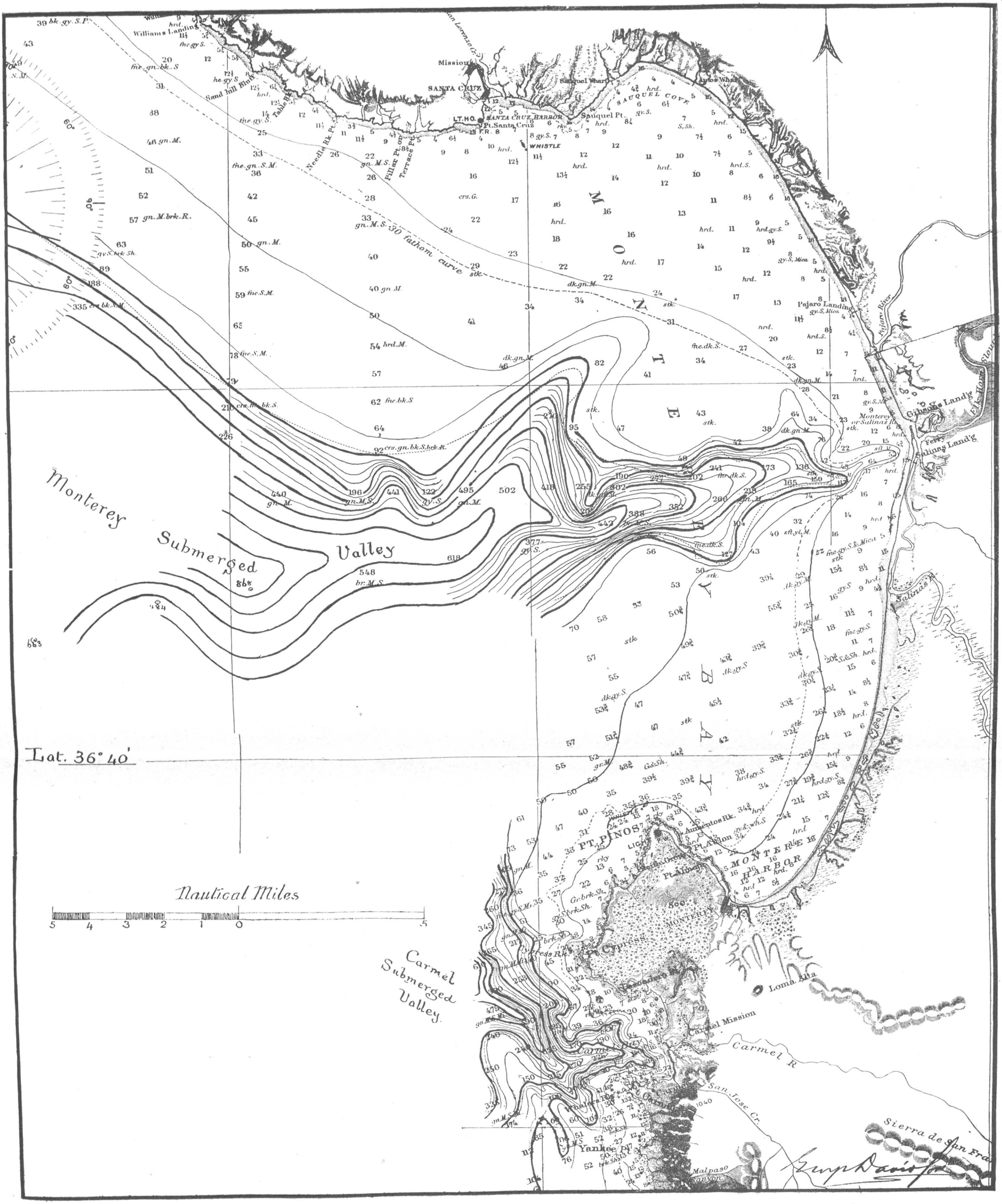


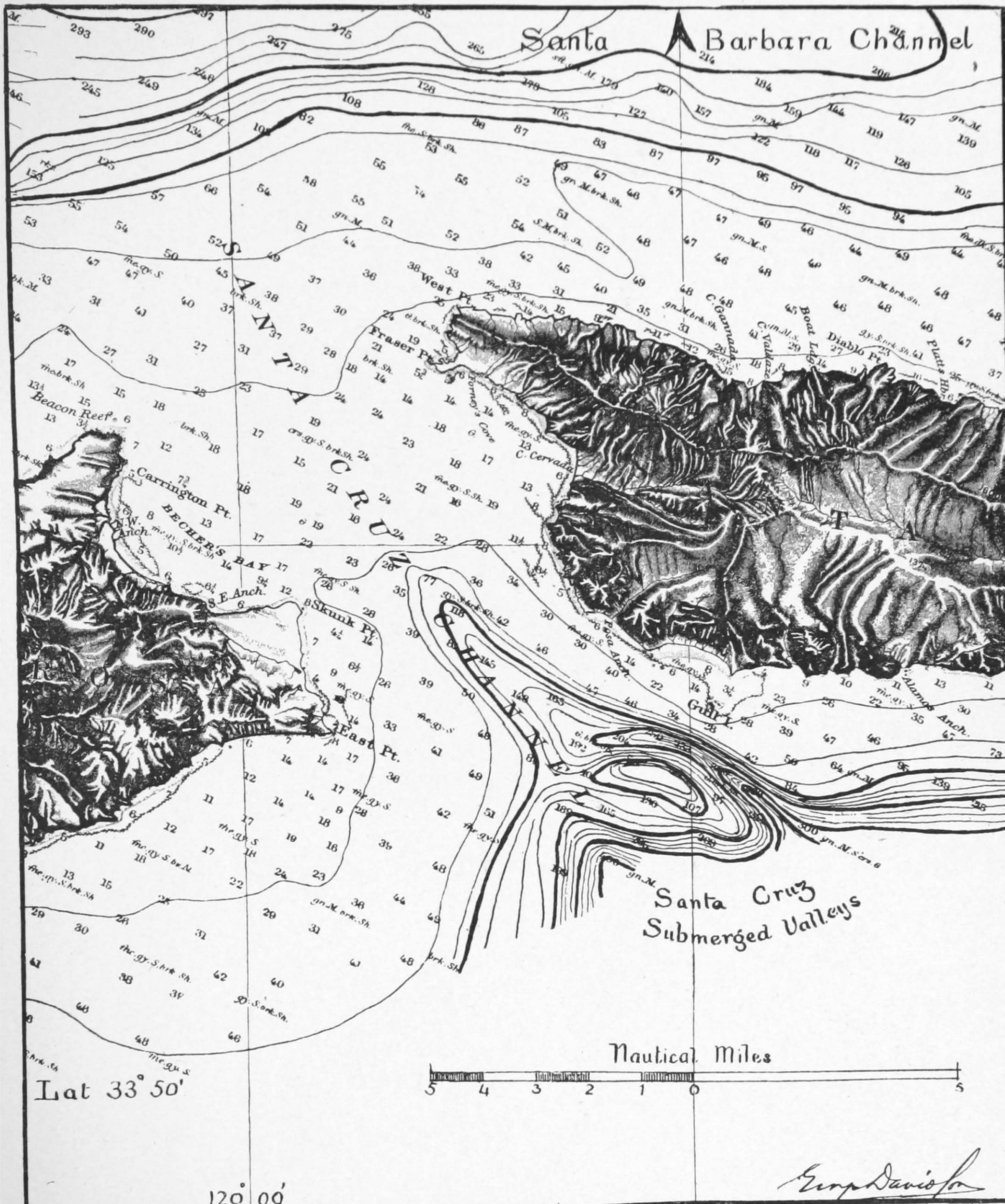
Nautical Miles.
5 4 3 2 1 0 5
34° 00'
Plains of Los Angeles
Santa Clara Valley
Lat 34° 10'
SANTA MONICA MOUNTAINS
Saddle Mt.
Santa Monica
Arcadia Hotel
Port Ballona
Kellers Shelter
Cañada Luna
Dume Anchorage
PT. DUME
San Buenaventura
Santa Clara R.
Hueneme
Pt. Hueneme
LIGHT
Middle Pt.
Laguna
Pt. Mugu
MONICA
BAY
10 fathom curve
30 fathom curve
100 fathom curve
Redondo Beach
Oil Well
Rocky Pt.
Eastern Entrance
Santa Barbara
Channel
ANACAPA ISLAND
PASSAGE
Hueneme Submerged Valley
Mugu Submerged Valley
Point Dume Submerged Valley
Santa Monica Submerged Valley
Vincente Submerged Valley
Var. 14° 55' E.
San Pedro Channel.
119° 10'
118° 50'
Geo Davidson

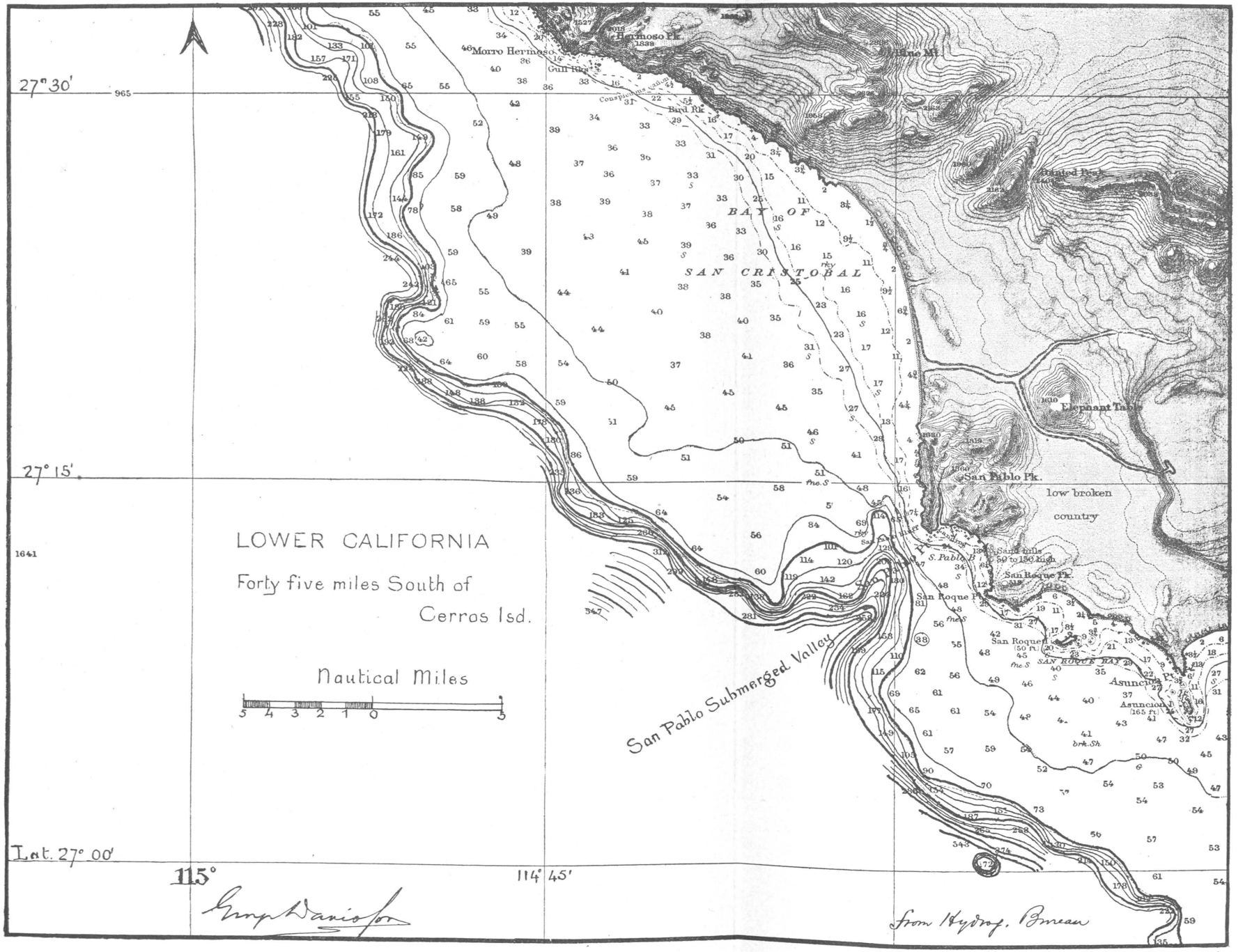

Nautical Miles
5 4 3 2 1 0 5
The Great Divide
Santa Catalina
Submerged Valley
Lat. 33° 20'
Geo. Davidson
118° 10'

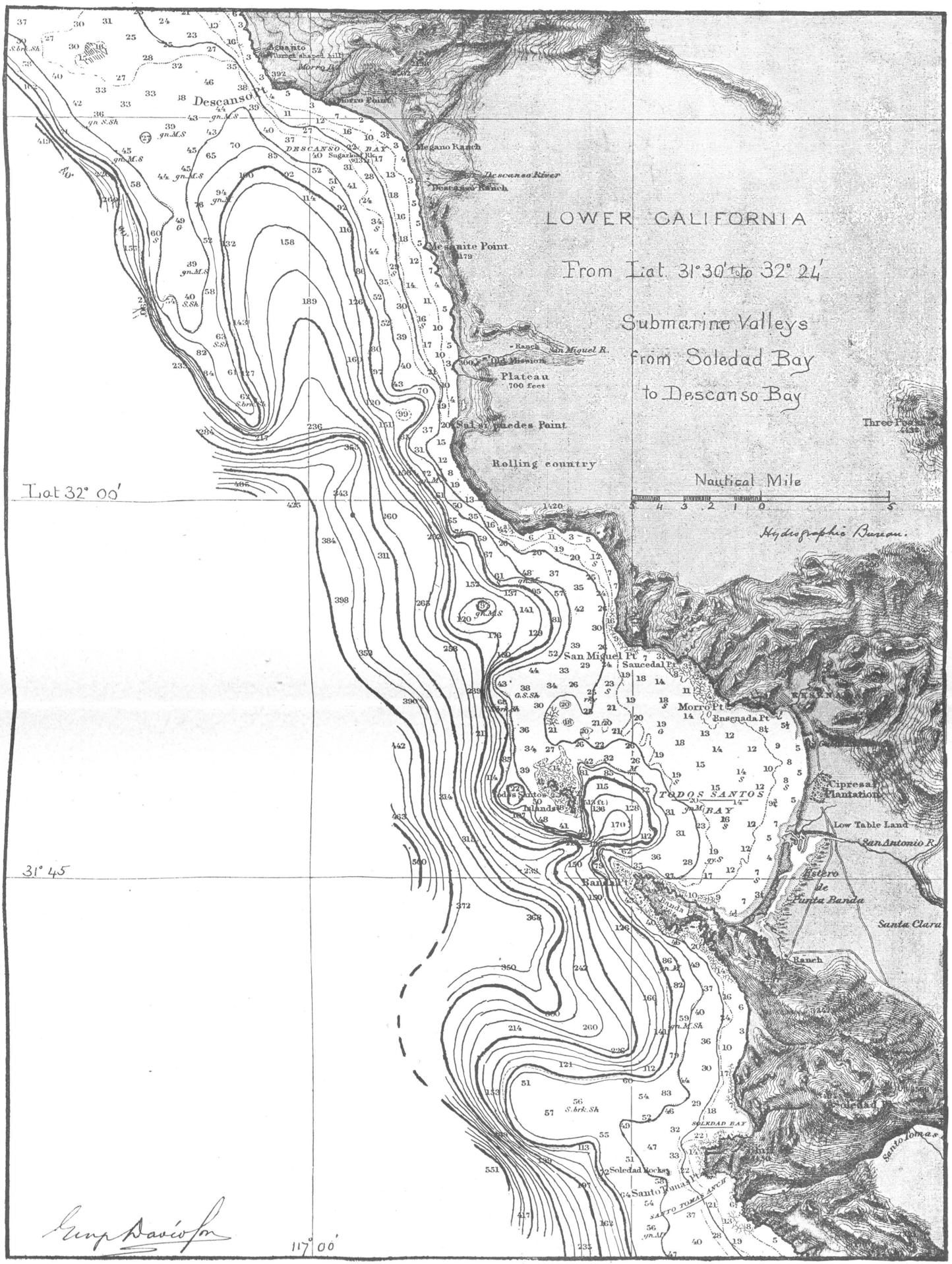


[DAVIDSON] PLATE VIII


Monterey Submerged Valley
Carmel Submerged Valley
Lat. 36° 40'
Nautical Miles
5 4 3 2 1 0 5
MONTEREY BAY
MONTEREY HARBOR
SANTA CRUZ
Pt. Santa Cruz
SAUQUEL COVE
Sauquel Pt.
Williams Landing
Pajaro Landing
Gibson's Land'g
Salinas Land'g
PT. PINOS
Carmel R.
Carmel Mission
Loma Alta
Sierra de San Fra
30 fathom curve
Geo. Davidson


Santa Barbara Channel
SANTA CRUZ CHANNEL
West Pt.
Fraser Pt.
Beacon Reef
Carrington Pt.
BECHER'S BAY
N.W. Anch.
S.E. Anch.
Skunk Pt.
East Pt.
C. Cervada
Forney's Cove
C. Gannada
Boat Ldg.
Diablo Pt.
Platts Hb.
Alamos Anch.
Gull I.
Santa Cruz
Submerged Valleys
Nautical Miles
5 4 3 2 1 0 5
Lat 33° 50'
120° 00'
Geo. Davidson


27° 30'
27° 15'
Lat. 27° 00'
115°
114° 45'
Morro Hermoso
Hermoso Pt.
Gull Rks.
Bird Rk.
Pinnacle Rock
Elephant Tank
San Pablo Pk.
low broken
country
BAY OF
SAN CRISTOBAL
LOWER CALIFORNIA
Forty five miles South of
Cerros Isd.
Nautical Miles
5 4 3 2 1 0 5
San Pablo Submerged Valley
San Roque Pk.
San Roque Pt.
SAN ROQUE BAY
Asuncion Pt.
Asuncion I.
(165 Ft.)
brk. Sh.
Comp. Davidson
from Hydrog. Bureau


LOWER CALIFORNIA
From Lat. 31° 30' to 32° 24'
Submarine Valleys
from Soledad Bay
to Descanso Bay
Hydrographic Bureau.
Nautical Mile
5 4 3 2 1 0 5
Lat 32° 00'
31° 45
117° 00'
Descanso
DESCANSO BAY
Agua to
Morro Point
Descanso Ranch
Descanso River
Mesquite Point
Plateau
700 feet
Rolling country
Sal si puedes Point
Three Rocks
San Miguel Pt
Saucedal Pt
Morro Pt
Ensenada Pt
TODOS SANTOS BAY
Todos Santos Islands
Cipresal Plantation
Low Table Land
San Antonio R.
Estero de Punta Banda
Santa Clara
Ranch
SOLEDAD BAY
Soledad Rocks
Santo Tomas
SANTO TOMAS ANCH

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