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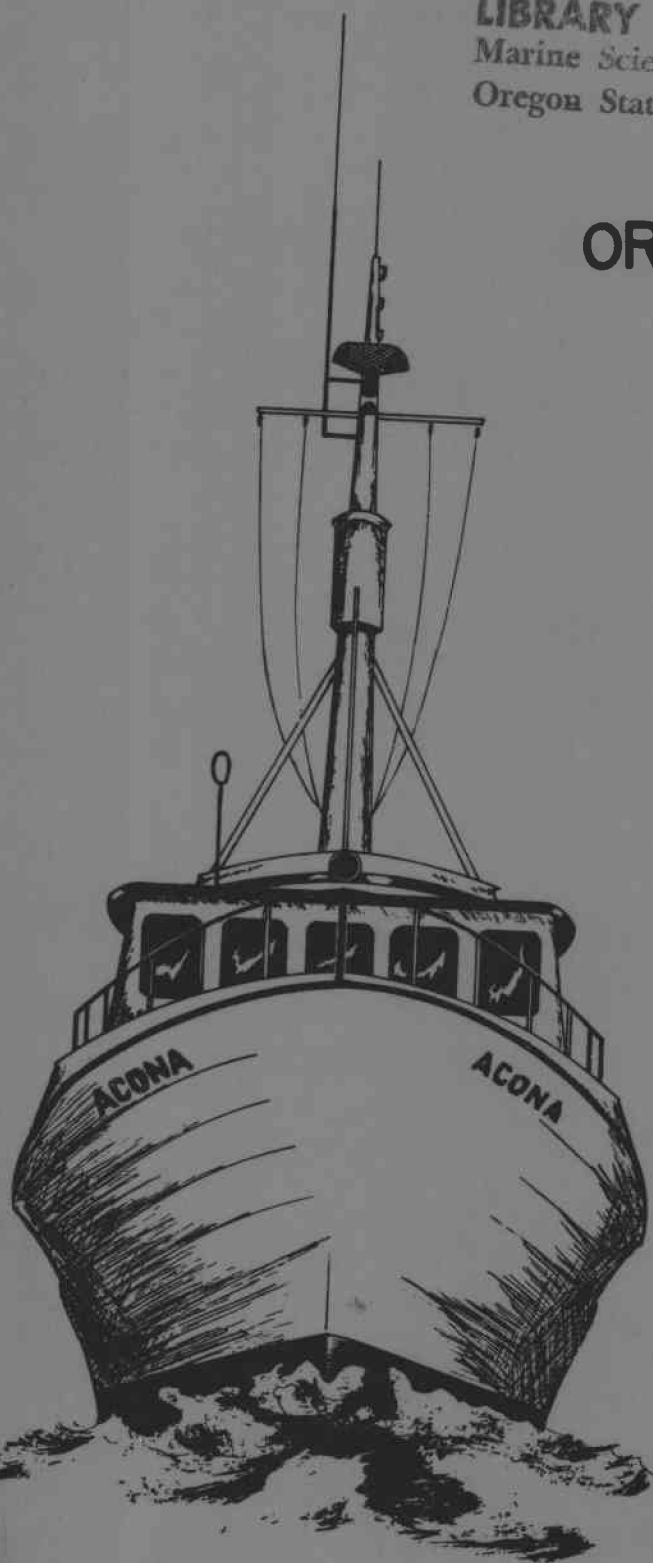
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Nearshore Marine Gravity Range, Newport, Oregon

Wilbur A. Rinehart and Joseph W. Berg, Jr.

Office of Naval Research
Contract Nonr 1286(02)
Project NR 083-102

National Science Foundation
Grant No. G 24353

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Date Report No. 9

Reference 63-16

July 1963

DEPARTMENT OF OCEANOGRAPHY

GEOPHYSICS RESEARCH GROUP

OREGON STATE UNIVERSITY

NEARSHORE MARINE GRAVITY RANGE, NEWPORT, OREGON

by

Wilbur A. Rinehart and Joseph W. Berg, Jr.

Data Report No. 9

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Wayne V. Burt
Chairman

This report is preliminary to a final technical report. It is requested that permission be obtained from the Geophysics Research Group of the Department of Oceanography, Oregon State University, to use the included data for purposes other than gravity meter calibrations.

NEARSHORE MARINE GRAVITY RANGE,

NEWPORT, OREGON

by

Wilbur A. Rinehart and Joseph W. Berg, Jr.

Abstract

Gravity observations were made with the LaCoste-Romberg underwater gravity meter during July and August 1962 at 149 stations in an area 10 by 40 miles ($44^{\circ}10'$ to $44^{\circ}50'N$ latitude and $124^{\circ}07'$ to $124^{\circ}20'W$ longitude) off the north-central Oregon coast from Heceta Head to Depoe Bay. The primary purpose of this gravity survey was to establish a calibration range for a surface-ship gravity meter.

Reoccupation of selected stations indicate, with about a 90 percent degree of confidence, that the contour lines on the surface gravity map are accurate to 1.0 mgal.

Introduction

Anticipating the use of a surface-ship gravity meter off the West Coast of the United States by marine geophysicists, the Geophysics Research Group of the Department of Oceanography, Oregon State University, established a nearshore marine gravity range along the north-central Oregon coast whereby a surface gravity meter could be calibrated.

The geographic area of interest is bounded by the coordinates $44^{\circ}10'$ to $44^{\circ}50'$ north latitude and $124^{\circ}07'$ to $124^{\circ}20'$ west longitude (Figure 1). A total of 149 gravity stations were established, and ten of these were reoccupied to determine the precision of measurement. The station spacing averaged about three miles over the entire range and about one mile over the central portion off Newport, Oregon.

A LaCoste-Romberg underwater gravity meter was used for this survey. This meter is a self-leveling instrument having low drift characteristics and is read by remote-controlled electrical devices. The meter has been described fully in the literature (LaCoste, 1948). The U.S. Coast Guard provided ship time and personnel to assist with handling

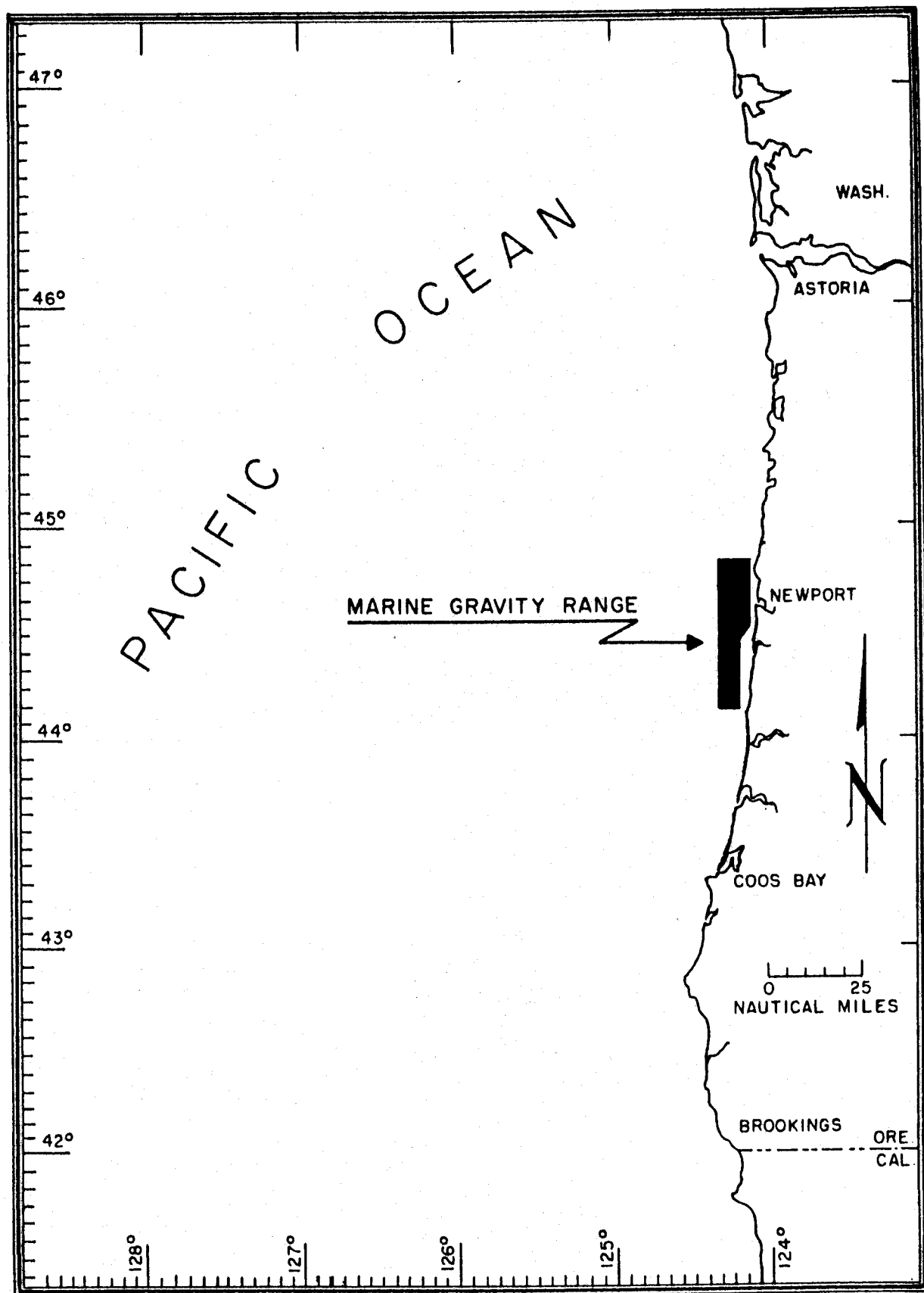


Figure 1. Index map showing the location of the marine gravity range.

the meter at sea. Gravity data were collected during two cruises from 7 to 14 July and 28 July to 1 August 1962 aboard the USCGC MODOC. The location of the gravity stations was obtained by radar ranges, visual bearings, and loran fixes. Depth of bottom at each station was read from a fathometer. Minimum depth was 20 fathoms; maximum depth was 50 fathoms.

Measurement Procedure

The primary base station for the gravity range is located near the west end of the paint locker at the U.S. Coast Guard Station, Newport, Oregon. The site is two feet south of the locker and is beneath an overhanging light by the locker door. Base ties between this station and stations in Woollard's airport network of gravity stations (Woollard, 1958; Behrendt and Woollard, 1961) located at the Corvallis, Eugene, and North Bend airports were made using a Worden gravity meter. The observed gravity at the Coast Guard base stations is 980610.4 mgals.

The base station at sea, Station 2, has the coordinates $44^{\circ}35.89'N$ and $124^{\circ}06.77'W$. This is located about three miles southwest of the Newport harbor entrance and 300 yards northwest of the sea buoy, in 20 fathoms of water. This base station was tied to the primary base by four observations. For drift control, this site was occupied at least three times a day, except when the gravity range was extended. In this case, Stations 176, 180, and 190 were established as temporary base stations.

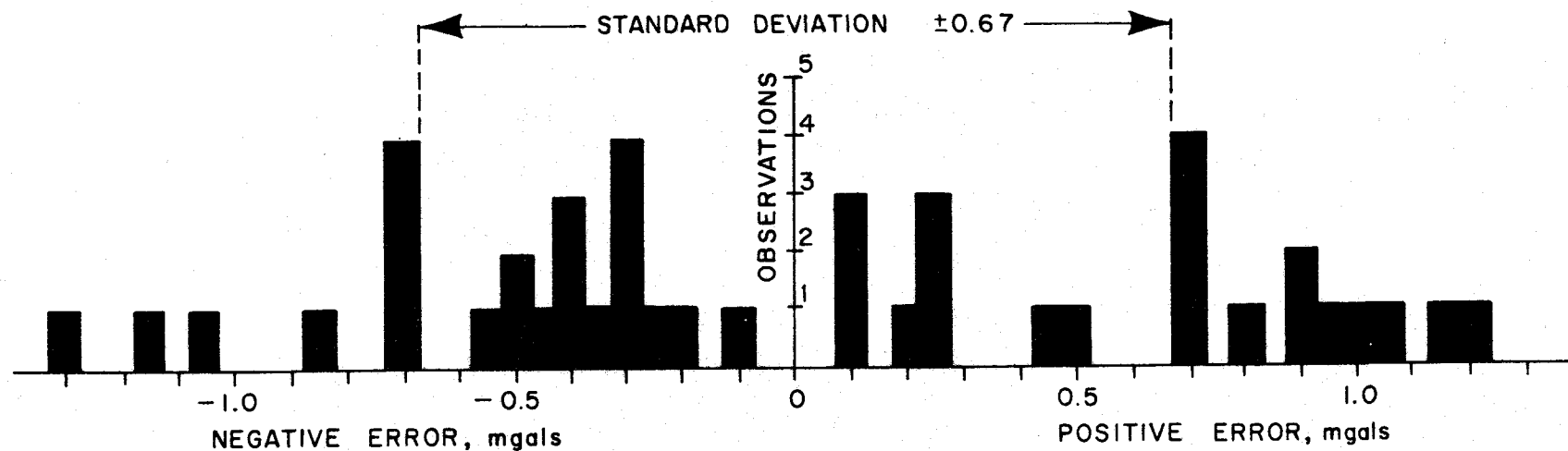
To control the drift of the instrument, all gravity stations in the range were established by making observations between times of two successive sea base readings. The average time between sea base readings was about seven hours.

At each station a temporary reference marker was provided so that the ship could be maneuvered without the danger of dragging the meter on the bottom. The marker consisted of a toy balloon attached to a ten-pound-test nylon monofilament line lowered with a three-pound lead weight. When the marker was in place, the gravity meter was lowered to the sea bottom, read, and recovered. The fact that it was necessary to reoccupy only seven stations because of ship movement indicates that the reference marker method was worthwhile.

Data Reduction

Gravity observations for all stations are listed in Table I. Included are the latitude, longitude, depth, observed gravity, and surface gravity of each station. The observed gravity is the drift-corrected meter reading multiplied by the scale constant (0.1057 mgals/scale division). Surface gravity has been obtained by correcting the observed gravity for free air lift to the surface and for depth of water.

a. Error analysis for all repeated stations



b. Gravity values at Station 2.

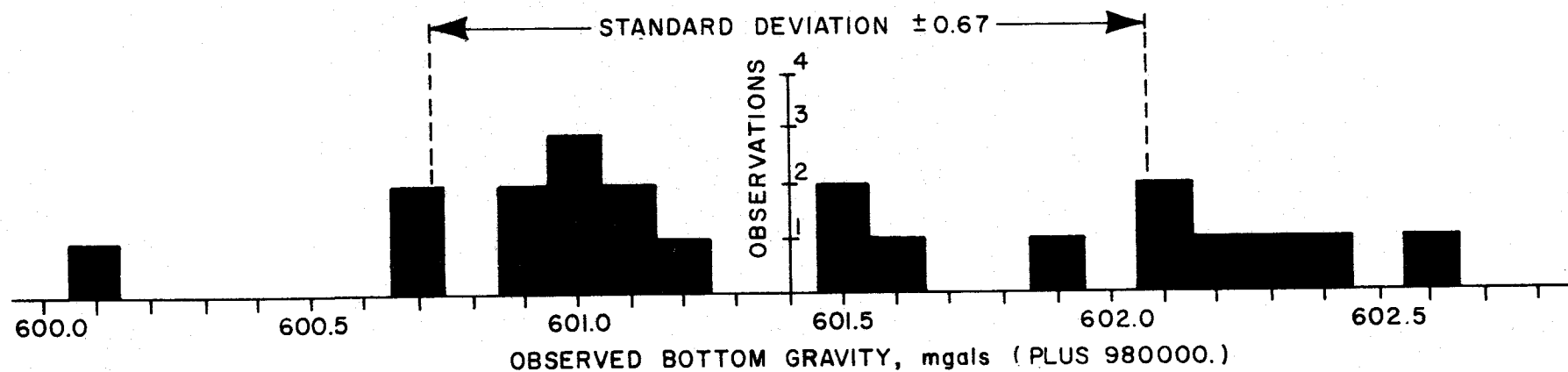


Figure 2. Histogram of the frequency distribution of the measurement errors of the gravity observations.

A drift curve was used to correct the readings for the drift of the meter. This curve was computed by the method of least squares using the meter readings from Station 2, corrected for slight difference in depth and position. The meter drift was found to be approximately 0.07 mgal per day.

The observed gravity for each station was referred to a mean sea level datum by subtracting the product of the free air correction (0.094 mgal/ft) and the depth (ft) from the observed bottom gravity. A correction was made for the water column by twice adding the gravity of an infinite slab of water of density 1.03 gm/cm^3 and thickness equal to the depth to the observed gravity corrected for free air lift to the surface. The topographic relief of the bottom is small, and corrections for it were not applied to the data.

Forty-four readings were included in the statistical analysis of the reliability of the data. In addition to the 21 made at Station 2, 23 readings were made by occupying nine other stations¹ two or more times. Small corrections were made to each of these meter readings to account for meter drift and for changes in depth and position. The gravity values for these repeated stations were analyzed to check the precision of the data.

The frequency distribution of errors of observations at all these repeated stations with respect to the mean values at these stations is presented in Figure 2a. The statistical error for all these observations, disregarding sign, is 0.57 mgal. The standard deviation is 0.67 mgal. Of the 44 readings, 48% had errors less than 0.5 mgal, 73% less than 0.8 mgal, and 86% less than 1.0 mgal.

The frequency distribution of gravity values with respect to the mean value at Station 2, where 21 readings were made, is presented in Figure 2b. The mean value at this station is 980601.4 mgal, and the standard deviation is 0.67 mgal. At this station 57% of the readings had errors of less than 0.5 mgal, 81% less than 0.8 mgal, and 90% less than 1.0 mgal.

The nearshore marine gravity range is presented in Figure 3. The surface gravity values obtained from these data reduction methods were plotted and contoured using a 5 mgal contour interval.

Conclusion

The estimates of precision of the data given above indicate that the contour lines on the surface gravity map (Figure 3) are accurate to one mgal with a 90 percent degree of confidence. If a ship carrying a

¹ Stations No. 4, 8, 26, 56, 84, 131, 176, 180, 190

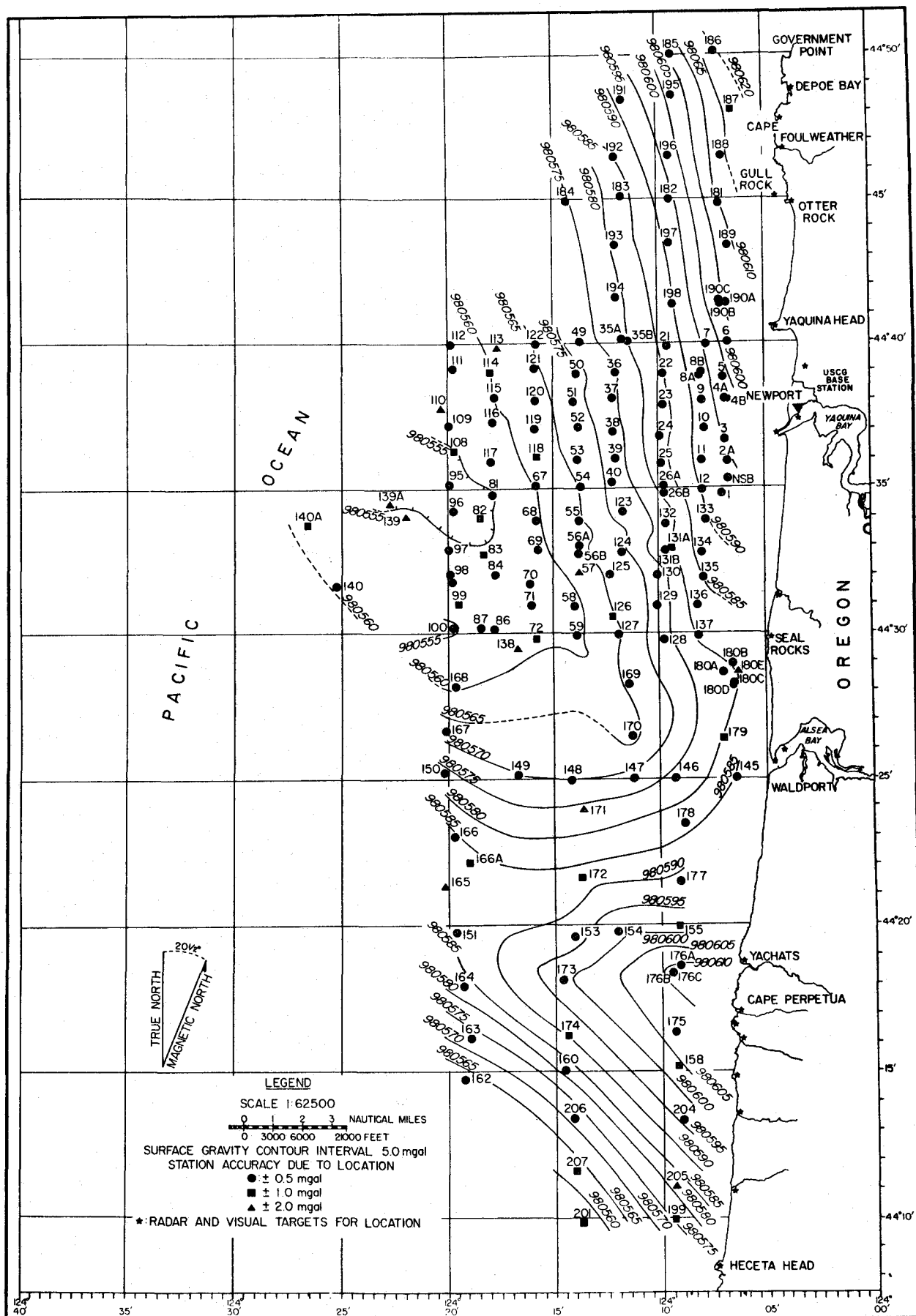


Figure 3. Marine gravity range off Newport, Oregon

surface gravity meter sails west from Newport, Oregon, to $124^{\circ}20'$, a distance of about 10 miles, a gravity difference of 49 mgal will be encountered. This range of gravity values is believed to be satisfactory to calibrate a surface gravity meter in moderate seas.

Acknowledgments

The A and M College of Texas loaned the underwater gravity meter to the Geophysics Research Group. LaCoste and Romberg Co. gave needed assistance and operating instructions. Mr. James Whitcomb and Mr. Arthur Albin assisted at sea. The U.S. Coast Guard provided ship time and space aboard the USCGC MODOC. The work was sponsored by the Office of Naval Research, Contract No. Nonr 1286(02), Project No. 083-102, and the National Science Foundation, Grant No. G 24353.

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- Behrendt, J. C., and G. P. Woollard, 1961. An evaluation of the gravity control network in North America, Geophysics, 26(1): 57-76.
- LaCoste, L. J. B., and A. Romberg, 1952. Force measuring device, U.S. Patent 2,589,710, March 18, 1952.
- Woollard, G. P., 1958. Results for a gravity control network at airports in the United States, Geophysics, 23(3): 520-535.

Table I. List of Gravity Stations

| Station Number | Latitude ° ' '' | Longitude ° ' '' | Depth* Feet | Observed Gravity mgal. | Surface Gravity mgal. |
|-------------------|------------------------|-------------------------|----------------|------------------------------|-----------------------------|
| NSB** | 44 35.29 | 124 06.75 | 90 | 980598.9 | 980592.8 |
| 1 | 44 34.80 | 124 07.000 | 107 | 601.2 | 593.9 |
| 2A | 44 35.89 | 124 06.77 | 114 | 602.4 | 594.6 |
| 2A' | 44 35.89 | 124 06.77 | 114 | 602.1 | 594.4 |
| 2B | 44 35.89 | 124 07.07 | 114 | 602.4 | 594.6 |
| 2B' | 44 35.89 | 124 07.07 | 114 | 603.0 | 595.5 |
| 2B'' | 44 35.89 | 124 07.07 | 114 | 602.6 | 594.8 |
| 2C | 44 35.87 | 124 07.12 | 109 | 603.2 | 595.8 |
| 2D | 44 35.88 | 124 06.92 | 106 | 602.6 | 595.3 |
| 2E | 44 35.97 | 124 06.75 | 104 | 603.7 | 596.6 |
| 2F | 44 36.06 | 124 06.74 | 110 | 603.0 | 595.5 |
| 2G | 44 35.88 | 124 06.92 | 101 | 603.4 | 596.5 |
| 2H | 44 35.96 | 124 06.98 | 116 | 603.4 | 595.5 |
| 2I | 44 35.95 | 124 06.92 | 110 | 603.5 | 595.8 |
| 2J | 44 35.87 | 124 07.21 | 110 | 603.2 | 595.7 |
| 2K | 44 35.88 | 124 07.03 | 120 | 602.6 | 594.4 |
| 2L | 44 35.97 | 124 07.04 | 141 | 603.0 | 593.4 |
| 2M | 44 35.96 | 124 07.14 | 116 | 602.2 | 594.3 |
| 2N | 44 35.99 | 124 07.07 | 116 | 602.9 | 595.0 |
| 2Ø | 44 36.02 | 124 06.91 | 121 | 602.8 | 594.5 |
| 2P | 44 36.06 | 124 06.88 | 110 | 602.6 | 595.2 |
| 2Q | 44 35.98 | 124 07.20 | 126 | 602.7 | 594.2 |
| 2R | 44 36.07 | 124 01.00 | 114 | 602.6 | 594.8 |
| 3 | 44 36.64 | 124 06.88 | 119 | 603.6 | 595.5 |
| 4A | 44 38.05 | 124 06.87 | 131 | 604.4 | 595.5 |
| 4B | 44 38.05 | 124 06.78 | 136 | 607.2 | 597.9 |
| 5 | 44 38.79 | 124 06.98 | 135 | 607.9 | 599.0 |
| 6 | 44 40.03 | 124 06.77 | 128 | 610.8 | 602.1 |
| 7 | 44 39.94 | 124 07.72 | 146 | 606.5 | 596.6 |
| 8A | 44 38.88 | 124 08.06 | 144 | 602.2 | 592.4 |
| 8B | 44 38.99 | 124 07.97 | 157 | 603.0 | 592.4 |
| 9 | 44 38.00 | 124 07.91 | 143 | 602.0 | 592.3 |
| 10 | 44 37.04 | 124 07.82 | 143 | 601.9 | 592.2 |
| 11 | 44 35.95 | 124 07.97 | 138 | 600.4 | 591.0 |
| 12 | 44 34.91 | 124 07.95 | 132 | 599.4 | 590.4 |
| 21 | 44 39.87 | 124 09.63 | 154 | 597.3 | 586.8 |
| 22 | 44 38.96 | 124 09.84 | 153 | 595.3 | 584.9 |
| 23 | 44 37.85 | 124 09.81 | 152 | 593.9 | 583.6 |
| 24 | 44 36.78 | 124 09.95 | 158 | 593.2 | 582.5 |
| 25 | 44 35.83 | 124 09.92 | 151 | 593.8 | 583.5 |
| 26A | 44 35.07 | 124 09.81 | 152 | 592.2 | 581.9 |
| 26B | 44 34.82 | 124 09.81 | 146 | 602.2 | 581.2 |
| 35A | 44 40.12 | 124 11.73 | 196 | 591.3 | 578.0 |
| 35B | 44 40.06 | 124 11.45 | 194 | 593.2 | 580.0 |
| 36 | 44 38.98 | 124 12.05 | 197 | 587.8 | 574.4 |
| 37 | 44 38.10 | 124 12.18 | 191 | 587.5 | 574.1 |

| Station Number | Latitude ° | Longitude ° | Depth Feet | Observed Gravity mgal. | Surface Gravity mgal. |
|-------------------|---------------|----------------|---------------|------------------------------|-----------------------------|
| 38 | 44 36.95 | 124 12.18 | 191 | 980585.5 | 980572.5 |
| 39 | 44 36.02 | 124 12.05 | 185 | 585.3 | 572.7 |
| 40 | 44 35.20 | 124 12.25 | 190 | 583.9 | 571.0 |
| 49 | 44 40.06 | 124 13.75 | 217 | 588.0 | 573.2 |
| 50 | 44 38.95 | 124 13.90 | 228 | 583.7 | 568.2 |
| 51 | 44 37.99 | 124 14.20 | 210 | 582.4 | 568.1 |
| 52 | 44 37.12 | 124 13.81 | 203 | 581.5 | 567.7 |
| 53 | 44 36.00 | 124 13.85 | 215 | 581.1 | 566.5 |
| 54 | 44 35.04 | 124 13.71 | 215 | 579.9 | 565.3 |
| 55 | 44 33.90 | 124 13.80 | 215 | 579.0 | 564.4 |
| 56A | 44 33.06 | 124 13.80 | 210 | 577.4 | 563.1 |
| 56B | 44 32.75 | 124 13.87 | 216 | 578.0 | 563.7 |
| 57 | 44 32.03 | 124 13.81 | 216 | 575.6 | 560.9 |
| 58 | 44 30.92 | 124 14.00 | 216 | 574.6 | 559.1 |
| 59 | 44 29.92 | 124 13.92 | 210 | 573.5 | 559.2 |
| 67 | 44 35.08 | 124 15.86 | 230 | 575.7 | 560.1 |
| 68 | 44 33.89 | 124 15.82 | 236 | 575.5 | 558.5 |
| 69 | 44 32.92 | 124 15.74 | 232 | 574.6 | 558.8 |
| 70 | 44 31.67 | 124 16.14 | 229 | 574.2 | 558.7 |
| 71 | 44 30.97 | 124 16.08 | 228 | 573.8 | 558.7 |
| 72 | 44 29.82 | 124 15.78 | 222 | 573.8 | 558.3 |
| 81 | 44 34.78 | 124 17.88 | 269 | 573.1 | 554.8 |
| 82 | 44 34.00 | 124 18.44 | 269 | 572.1 | 553.8 |
| 83 | 44 32.69 | 124 18.30 | 269 | 573.7 | 555.4 |
| 84A | 44 31.98 | 124 17.76 | 256 | 574.2 | 556.8 |
| 84B | 44 31.98 | 124 17.76 | 255 | 574.2 | 556.9 |
| 86 | 44 30.13 | 124 17.80 | 249 | 576.9 | 560.0 |
| 87 | 44 30.17 | 124 18.43 | 242 | 574.2 | 557.7 |
| 95 | 44 35.13 | 124 19.44 | 245 | 570.8 | 554.1 |
| 96 | 44 34.23 | 124 19.71 | 252 | 570.9 | 553.7 |
| 97 | 44 32.91 | 124 19.94 | 247 | 572.3 | 555.5 |
| 98 | 44 31.99 | 124 19.90 | 265 | 573.6 | 555.6 |
| 99 | 44 31.00 | 124 19.50 | 242 | 573.6 | 557.1 |
| 100 | 44 30.17 | 124 19.74 | 254 | 571.8 | 554.5 |
| 105 | 44 31.72 | 124 19.77 | 266 | 573.6 | 555.5 |
| 108 | 44 36.31 | 124 19.71 | 233 | 570.7 | 554.9 |
| 109 | 44 37.18 | 124 19.92 | 232 | 571.2 | 555.4 |
| 110 | 44 37.73 | 124 20.29 | 241 | 572.1 | 555.7 |
| 111 | 44 39.11 | 124 19.72 | 250 | 573.9 | 556.9 |
| 112 | 44 39.97 | 124 19.83 | 256 | 575.3 | 557.9 |
| 113 | 44 39.82 | 124 17.60 | 250 | 578.1 | 561.1 |
| 114 | 44 39.00 | 124 18.00 | 249 | 576.6 | 559.7 |
| 115 | 44 38.11 | 124 17.75 | 240 | 576.5 | 560.2 |
| 116 | 44 37.29 | 124 18.86 | 248 | 575.3 | 558.5 |
| 117 | 44 35.91 | 124 17.92 | 250 | 573.3 | 556.1 |
| 118 | 44 36.09 | 124 15.82 | 230 | 577.9 | 562.3 |
| 119 | 44 37.08 | 124 15.90 | 235 | 578.1 | 562.1 |
| 120 | 44 38.20 | 124 15.89 | 235 | 578.6 | 562.7 |
| 121 | 44 39.12 | 124 15.90 | 234 | 580.5 | 564.6 |

| Station Number | Latitude ° | Longitude ° | Depth Feet | Observed Gravity mgal. | Surface Gravity mgal. |
|-------------------|---------------|----------------|---------------|------------------------------|-----------------------------|
| 122 | 44 39.95 | 124 15.85 | 234 | 980581.0 | 980565.1 |
| 123 | 44 34.19 | 124 11.71 | 178 | 584.2 | 572.1 |
| 124 | 44 32.80 | 124 11.82 | 184 | 581.7 | 569.2 |
| 125 | 44 32.00 | 124 12.33 | 189 | 579.4 | 566.5 |
| 126 | 44 30.56 | 124 12.24 | 188 | 577.5 | 564.7 |
| 127 | 44 29.95 | 124 11.93 | 176 | 576.2 | 564.3 |
| 128 | 44 29.78 | 124 09.83 | 150 | 583.7 | 573.5 |
| 129 | 44 30.96 | 124 10.04 | 155 | 584.4 | 571.8 |
| 130 | 44 31.98 | 124 10.07 | 155 | 585.8 | 573.2 |
| 131A | 44 32.94 | 124 09.48 | 157 | 590.4 | 579.3 |
| 131B | 44 32.82 | 124 09.75 | 145 | 588.7 | 578.9 |
| 132 | 44 33.79 | 124 09.75 | 163 | 588.1 | 577.0 |
| 133 | 44 33.89 | 124 07.79 | 133 | 598.2 | 589.1 |
| 134 | 44 32.79 | 124 08.00 | 133 | 596.0 | 586.9 |
| 135 | 44 31.88 | 124 07.96 | 124 | 593.6 | 585.1 |
| 136 | 44 30.95 | 124 08.20 | 133 | 591.0 | 581.9 |
| 137 | 44 29.90 | 124 08.18 | 127 | 589.0 | 580.4 |
| 138 | 44 29.44 | 124 16.69 | 237 | 574.3 | 558.2 |
| 139A | 44 34.47 | 124 22.68 | 204 | 568.4 | 554.6 |
| 139 | 44 34.04 | 124 21.95 | 199 | 569.4 | 555.9 |
| 140 | 44 31.58 | 124 25.21 | 165 | 571.9 | 560.7 |
| 140A | 44 33.79 | 124 26.56 | 213 | 576.5 | 562.0 |
| 145 | 44 25.02 | 124 06.48 | 77 | 590.8 | 585.5 |
| 146 | 44 25.00 | 124 09.36 | 142 | 586.4 | 576.7 |
| 147 | 44 25.04 | 124 11.28 | 169 | 583.0 | 571.5 |
| 148 | 44 24.96 | 124 14.20 | 204 | 584.1 | 570.2 |
| 149 | 44 25.10 | 124 16.69 | 225 | 585.8 | 570.5 |
| 150 | 44 25.20 | 124 20.20 | 231 | 591.8 | 576.1 |
| 151 | 44 19.77 | 124 19.65 | 248 | 603.9 | 587.0 |
| 153 | 44 19.60 | 124 14.10 | 211 | 607.9 | 593.6 |
| 154 | 44 19.63 | 124 12.05 | 170 | 610.2 | 598.6 |
| 155 | 44 19.96 | 124 09.18 | 140 | 606.6 | 597.0 |
| 158 | 44 15.15 | 124 09.31 | 132 | 613.8 | 604.8 |
| 160 | 44 15.06 | 124 14.56 | 211 | 596.6 | 582.3 |
| 162 | 44 14.71 | 124 19.22 | 255 | 580.0 | 562.6 |
| 163 | 44 16.12 | 124 18.95 | 249 | 589.9 | 573.0 |
| 164 | 44 17.92 | 124 19.24 | 248 | 599.9 | 583.0 |
| 165 | 44 21.30 | 124 20.13 | 229 | 603.4 | 587.8 |
| 166 | 44 23.02 | 124 19.71 | 223 | 600.9 | 585.8 |
| 166A | 44 22.13 | 124 18.98 | 228 | 602.0 | 586.5 |
| 167 | 44 26.63 | 124 20.11 | 231 | 583.0 | 567.3 |
| 168 | 44 28.17 | 124 19.62 | 225 | 574.9 | 559.6 |
| 169 | 44 28.26 | 124 11.46 | 170 | 577.0 | 565.5 |
| 170 | 44 26.45 | 124 11.30 | 205 | 577.7 | 563.8 |
| 171 | 44 23.94 | 124 13.61 | 204 | 590.0 | 576.2 |
| 172 | 44 21.63 | 124 13.74 | 199 | 600.8 | 587.2 |
| 173 | 44 18.11 | 124 14.63 | 204 | 612.9 | 599.0 |
| 174 | 44 16.23 | 124 14.41 | 210 | 604.6 | 590.3 |
| 175 | 44 16.31 | 124 09.42 | 138 | 616.5 | 607.2 |
| 176A | 44 18.59 | 124 09.18 | 156 | 621.2 | 610.6 |

| Station Number | Latitude ° | Longitude ° | Depth Feet | Observed Gravity mgal. | Surface Gravity mgal. |
|----------------|---------------|----------------|---------------|------------------------------|-----------------------------|
| 176B | 44 18.36 | 124 09.50 | 144 | 980621.0 | 980611.2 |
| 176C | 44 18.36 | 124 09.50 | 148 | 621.4 | 611.3 |
| 177 | 44 21.48 | 124 09.12 | 141 | 601.4 | 591.8 |
| 178 | 44 23.47 | 124 08.88 | 141 | 592.8 | 583.2 |
| 179 | 44 26.40 | 124 07.05 | 114 | 587.9 | 580.1 |
| 180A | 44 28.64 | 124 07.00 | 105 | 587.0 | 579.8 |
| 180B | 44 28.93 | 124 06.60 | 98 | 586.8 | 580.1 |
| 180C | 44 28.27 | 124 06.53 | 110 | 586.4 | 578.9 |
| 180D | 44 28.22 | 124 06.54 | 127 | 586.9 | 578.3 |
| 180E | 44 28.68 | 124 06.31 | 81 | 586.0 | 580.5 |
| 181 | 44 44.83 | 124 07.03 | 160 | 620.8 | 609.9 |
| 182 | 44 44.96 | 124 09.45 | 198 | 607.0 | 593.5 |
| 183 | 44 45.08 | 124 11.71 | 225 | 598.0 | 582.7 |
| 184 | 44 44.90 | 124 14.27 | 256 | 592.0 | 574.6 |
| 185 | 44 50.00 | 124 09.24 | 198 | 620.5 | 607.1 |
| 186 | 44 50.11 | 124 07.19 | 174 | 630.7 | 618.9 |
| 187 | 44 48.02 | 124 06.44 | 164 | 628.0 | 616.9 |
| 188 | 44 46.45 | 124 06.91 | 159 | 623.9 | 613.1 |
| 189 | 44 43.40 | 124 06.68 | 132 | 617.6 | 608.7 |
| 190A | 44 41.38 | 124 06.78 | 132 | 614.4 | 605.5 |
| 190B | 44 41.35 | 124 07.05 | 133 | 613.0 | 604.0 |
| 190C | 44 41.93 | 124 07.12 | 153 | 613.5 | 603.1 |
| 191 | 44 48.37 | 124 11.60 | 250 | 608.5 | 591.5 |
| 192 | 44 46.42 | 124 12.00 | 225 | 600.8 | 585.5 |
| 193 | 44 43.39 | 124 12.00 | 188 | 594.2 | 581.5 |
| 194 | 44 41.58 | 124 12.00 | 212 | 593.0 | 578.6 |
| 195 | 44 48.55 | 124 09.22 | 211 | 615.3 | 600.9 |
| 196 | 44 46.47 | 124 09.40 | 204 | 610.8 | 597.0 |
| 197 | 44 43.45 | 124 09.45 | 186 | 603.8 | 591.2 |
| 198 | 44 41.36 | 124 09.35 | 175 | 601.3 | 589.4 |
| 199 | 44 09.95 | 124 09.43 | 136 | 586.0 | 576.8 |
| 201 | 44 09.85 | 124 13.72 | 207 | 570.5 | 556.4 |
| 204 | 44 13.46 | 124 09.08 | 131 | 604.9 | 596.0 |
| 205 | 44 11.07 | 124 09.40 | 131 | 591.1 | 582.2 |
| 206 | 44 13.42 | 124 14.15 | 218 | 586.5 | 571.1 |
| 207 | 44 11.59 | 124 14.06 | 218 | 577.8 | 563.0 |
| NPCG*** | 44 37.50 | 124 03.32 | 20* | 609.9 | 609.9 |
| NPCG | 44 37.58 | 124 03.32 | 20* | 610.7 | 610.7 |
| NPCG | 44 37.58 | 124 03.32 | 20* | 610.7 | 610.7 |
| NPCG | 44 37.58 | 124 03.32 | 20* | 610.7 | 610.7 |
| NPCG | 44 37.58 | 124 03.32 | 20* | 610.4 | 610.4 |

* Refers to mean sea level. Land station NPCG elevation above mean sea level.

** NSB designates a preliminary station positioned near the sea buoy.

*** NPCG designates the base station located at the Coast Guard station, Newport, and described in this report as the primary base station.

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