

**DEPARTMENT OF THE INTERIOR,  
UNITED STATES GEOLOGICAL  
SURVEY, BULLETIN 464: RESULTS  
OF SPIRIT LEVELING IN NEW  
MEXICO, 1902 TO 1909, INCLUSIVE**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649313921

Department of the interior, United States Geological Survey, Bulletin 464: Results of spirit leveling in new Mexico, 1902 to 1909, inclusive by R. B. Marshall

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**R. B. MARSHALL**

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DEPARTMENT OF THE INTERIOR  
UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

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BULLETIN 464

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RESULTS OF SPIRIT LEVELING  
IN NEW MEXICO

1902 TO 1909, INCLUSIVE

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R. B. MARSHALL, CHIEF GEOGRAPHER

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WASHINGTON  
GOVERNMENT PRINTING OFFICE  
1911

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## GEOLOGICAL SURVEY BENCH MARKS

*A*, Tablet used in cooperating States. The State name is inserted at *G*.  
*B* and *D*, Copper temporary bench mark consisting of a nail and copper washer.  
*A*, *C*, and *E*, Tablets for stone or concrete structures.  
*F*, Iron post used where there is no rock.

# RESULTS OF SPIRIT LEVELING IN NEW MEXICO, 1902 TO 1909, INCLUSIVE.

R. B. MARSHALL, Chief Geographer.

## INTRODUCTION.

*Scope of the work.*—All results of spirit leveling in New Mexico by the United States Geological Survey are included in this report, arranged by quadrangles. All elevations are based on preliminary heights of bench marks along the precise-level line of the Coast and Geodetic Survey from San Diego, Cal., via Mellen and Flagstaff, Ariz., to Albuquerque, N. Mex., and on the precise line of the United States Geological Survey from the Arizona-New Mexico boundary line via Rincon and Albuquerque to Cuba, N. Mex.

*Personnel.*—The field work from 1902 to 1906, inclusive, was done under E. M. Douglas, geographer, and the later work under E. C. Barnard, geographer, under the general direction of R. B. Marshall, chief geographer. The names of the various levelmen are given in the introduction to each list. The office work of computation, adjustment, and preparation of lists was done mainly by S. S. Gannett, geographer, and D. H. Baldwin, topographer, and since 1907 under the general direction of E. M. Douglas, geographer.

*Classification.*—The elevations are classified as precise or primary according to the methods employed in their determination. For precise-level lines instruments and rods of the highest grade are used; each line is run both forward and backward, and every precaution is taken to guard against error. The allowable divergence between the forward and the backward lines in feet is represented by the formula  $0.017\sqrt{D}$ , in which  $D$  is the distance in miles between bench marks. For primary lines standard  $\nabla$  levels are used; lines are run in circuits or are closed on precise lines, with an allowable closing error in feet represented by  $0.05\sqrt{D}$ , in which  $D$  is the length of the circuit in miles, sufficient care being given to the work to maintain this standard. For levels of both classes careful office adjustments are made, the small outstanding errors being distributed over the lines.



*Bench marks.*—The standard bench marks are of two forms. The first form is a circular bronze or aluminum tablet (*C* and *E*, Pl. I),  $3\frac{1}{2}$  inches in diameter and one-quarter inch thick, having a 3-inch stem, which is cemented in a drill hole in solid rock in the wall of some public building, a bridge abutment, or other substantial masonry structure. The second form (*F*, Pl. I), used where masonry or rock is not available, consists of a hollow wrought-iron post  $3\frac{1}{2}$  inches in outer diameter and 4 feet in length. The bottom is spread out to a width of 10 inches in order to give a firm bearing on the earth. A bronze cap is riveted over the top of the post, which is set about 3 feet in the ground. A third style of bench mark with abbreviated lettering (*B* and *D*, Pl. I) is used for unimportant points. This consists of a special copper nail  $1\frac{1}{2}$  inches in length driven through a copper washer seven-eighths inch in diameter. The tablets, as well as the caps on the iron posts, are appropriately lettered, and cooperation by States is indicated by the addition of the State name (*G*, Pl. I).

The numbers stamped on the bench marks described in the following pages represent the elevations to the nearest foot, as determined by the levelman. These numbers are stamped with  $\frac{1}{8}$ -inch steel dies on the tablets or post caps, to the left of the word "feet." The office adjustment of the notes and the reduction to mean sea-level datum may so change some of the figures that the original markings are 1 or 2 feet in error. It is assumed that engineers and others who have occasion to use the bench-mark elevations will apply to the Director of the United States Geological Survey, at Washington, D. C., for the adjusted values, and will use the markings as identification numbers only.

*Datum.*—All United States Geological Survey elevations are referred to mean sea level, which is the level that the sea would assume if the influence of tides and winds were eliminated. This level is not the elevation determined from the mean of the highest and the lowest tides, nor is it the half sum of the mean of all the high tides and the mean of all the low tides, which is called the half-tide level. *Mean sea level is the average height of the water, all stages of the tide being considered.* It is determined from observations made by means of tidal gages placed at stations where local conditions, such as long, narrow bays, rivers, and like features, will not affect the height of the water. To obtain even approximately correct results these observations must extend over at least one lunar month, and if accuracy is desired they must extend over several years. At ocean stations the half-tide level and the mean sea level usually differ but little. It is assumed that there is no difference between the mean sea level as determined from observations in the Atlantic Ocean, the Gulf of Mexico, or the Pacific Ocean.

The connection with tidal stations for bench marks in certain areas that lie at some distance from the seacoast is still uncertain, and this fact is indicated by the addition of a letter or word to the right of the word "Datum" on tablets or posts. For such areas corrections for published results will be made from time to time as the precise-level lines of the United States Geological Survey or other Government organizations are extended.

*Topographic maps.*—Maps of the following quadrangles wholly or partly in New Mexico have been published by the United States Geological Survey up to May 1, 1911. They may be obtained, except as noted, for 5 cents each or \$3 a hundred, on application to the Director of the Survey at Washington, D. C.

Albuquerque.	Las Cruces.
Bernal.	Las Vegas.
Canyon de Chelly (Ariz.-N. Mex.).	Mount Taylor.
Chaco.	St. Johns (Ariz.-N. Mex.).
Corazon.	San Pedro.
Deming.	Santa Clara.
Fort Bayard, special (10 cents).	Santa Fe.
Fort Defiance (Ariz.-N. Mex.).	Santa Rita, special.
Gallina.	Silver City.
Jemez.	Socorro.
Lamy.	Watrous.
Largo.	Wingate.

## PRECISE LEVELING.

Albuquerque, Engle, Las Cruces, Lajoya, Los Lunas, Rincon, San Marcial, Socorro, and Tenuco Quadrangles.

## BERNALILLO, DONA ANA, SIERRA, SOCORRO, AND VALENCIA COUNTIES.

The following are the results for the New Mexico portion of a precise level line run in 1905 by M. S. Bright along the Atchison, Topeka & Santa Fe Railway from Albuquerque, N. Mex., south to El Paso, Tex. The elevations are in accord with the height of a bench mark at Rincon determined by precise leveling from Yuma, and adjusted to the preliminary heights of bench marks near Albuquerque determined by the precise level line of the Coast and Geodetic Survey in 1909. By applying the orthometric correction to the elevations between Rincon and Albuquerque, a close agreement was obtained with the Coast and Geodetic Survey preliminary elevations near Albuquerque.

## ALBUQUERQUE QUADRANGLE.

Albuquerque south along Atchison, Topeka & Santa Fe Ry. to San Marcial (portion of line).

Albuquerque, corner of Railroad Avenue and First Street, at northwest corner of Alvarado Hotel grounds, in cement; iron post Feet.  
(Coast and Geodetic Survey, unadjusted value 1910)..... 4,952.241

	Feet.
Albuquerque, in front of station; top of rail.....	4,952.9
Albuquerque, southwest corner of Coal and Second Streets, 90 feet west of west end of viaduct over Atchison, Topeka & Santa Fe Ry. tracks, set in cement; iron post (Coast and Geodetic Survey unadjusted value 1910).....	4,949.904
Albuquerque, southeast corner of foundation of first pier west of main line of Atchison, Topeka & Santa Fe Ry. under south side of viaduct; cross.....	4,952.72
Albuquerque, 3.2 miles south of, 60 feet west of track, at third telegraph pole north of gate; iron post (Coast and Geodetic Survey, unadjusted value 1910).....	4,930.488

#### LOS LUNAS QUADRANGLE.

Albuquerque south along Atchison, Topeka & Santa Fe Ry. to San Marcial  
(portion of line).

Albuquerque, 6.3 miles south of, 900 feet south of milepost 909, 55 feet east of tracks, 18 feet south of gate; iron post (Coast and Geodetic Survey, unadjusted value 1910).....	4,927.064
Barr, in front of signboard; top of rail.....	4,911.7
Isleta, 3 miles north of, west of track, 100 feet northwest of milepost 912, at southeast corner of tool house; top of bolt.....	4,901.31
Isleta, 3 miles north of, 450 feet north of milepost 912, 600 feet north of section house, 100 feet east of track; iron post (Coast and Geodetic Survey, unadjusted value 1910).....	4,903.010
Isleta, 2 miles north of, on north pier of bridge over Rio Grande River east of track; chiseled square.....	4,900.72
Isleta, in front of station; top of rail.....	4,898.3
Isleta, 0.2 mile southwest of station, 50 feet west of El Paso line track, 200 feet east of transcontinental line track, 5 feet north of stone post. In cement; iron post (Coast and Geodetic Survey, unadjusted value 1910).....	4,890.086
Isleta, 2 miles south of, 500 feet south of milepost 917, on southwest cap of bridge 823; top of bolt.....	4,871.44
Isleta, 3.5 miles south of, 100 feet north of road crossing, 50 feet west of track; iron post.....	4,869.532
Los Lunas, 700 feet north of station, 60 feet west of track at road crossing, at northeast corner of Solomon Lunas's yard fence; iron post.....	4,851.396
Los Lunas, in front of station; top of rail.....	4,851.8
Los Lunas, 3 miles south of, 50 feet east of track, 10 feet north of gate; iron post.....	4,832.960
Los Lunas, 5.7 miles south of, 45 feet west of track, at road crossing; iron post.....	4,821.117
Belen, 1.2 miles north of, 50 feet east of track at road crossing; iron post.....	4,808.271
Belen, in front of station; top of rail.....	4,804.0
Belen, 1.7 miles south of, 50 feet west of junction with Belen cut-off, 200 feet south of milepost 934; iron post.....	4,793.130
Belen, 4.8 miles south of, 220 feet south of milepost 937, 50 feet west of track, 8 feet north of gate; iron post.....	4,793.673