

**DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL
SURVEY, BULLETIN 459: RESULTS
OF SPIRIT LEVELING IN MISSOURI
1896-1909, INCLUSIVE**

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R. B. MARSHALL

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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

BULLETIN 459

RESULTS OF SPIRIT LEVELING
IN MISSOURI

1896 TO 1909, INCLUSIVE

R. B. MARSHALL, CHIEF GEOGRAPHER

WORK DONE IN COOPERATION WITH THE STATE OF MISSOURI
FROM 1907 TO 1909, INCLUSIVE



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1911

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RESULTS OF SPIRIT LEVELING IN MISSOURI, 1896 TO 1909, INCLUSIVE.

R. B. MARSHALL, Chief Geographer.

INTRODUCTION.

Scope of the work.—All results of spirit leveling in the State of Missouri previously published by the United States Geological Survey and all the results of later work are included in this report, rearranged by quadrangles. All elevations are based on the precise level net as adjusted in 1907 by the Coast and Geodetic Survey to a common mean sea level datum. The part of this net which lies within or along the borders of Missouri comprises the line of the Coast and Geodetic Survey across the State from St. Louis to Kansas City and from Kansas City southward to the southwest corner of the State; the line of the Mississippi River Commission along the eastern boundary of the State; and the line of the Missouri River Commission along the Missouri River from its mouth northwestward to the northwest corner of the State.

Personnel.—The field work previous to 1903 was done under the general direction of J. H. Renshawe, geographer; that from 1903 to 1906, inclusive, under H. M. Wilson, geographer; and the later work under W. H. Herron, 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 known 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 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 Y levels are used; lines are run

in circuits or are closed on precise lines, with an allowable closing error represented in feet by the formula $0.05\sqrt{D}$, in which D is the length of the circuit in miles, sufficient care being given 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-fourth inch thick, having a 3-inch stem, which is cemented in a drill hole in solid rock in the wall of some public building, bridge abutment, or other substantial masonry structure. The second form (*F*, Pl. I), to be set in the ground where no masonry or rock is available, consists of a hollow wrought iron post $3\frac{1}{2}$ inches in outside diameter and 4 feet long. The bottom is spread out to a width of 10 inches in order to give a firm bearing on the earth. A bronze or aluminum-bronze cap is riveted over the top of the post. 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 where States have cooperated in the work the fact of such cooperation is indicated by the addition of the State name (*G*, Pl. I).

The numbers stamped on the bench marks described in the following pages are the elevations to the nearest foot as determined by the level man. These numbers are stamped with three-sixteenths 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 their adjusted values, using the markings as identification numbers only.

Datum.—All elevations taken by the United States Geological Survey 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 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 approxi-



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.