

**BULLETIN 453. RESULTS
OF SPIRIT
LEVELING IN MINNESOTA.
1897 TO 1910. INCLUSIVE**

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Bulletin 453. Results of Spirit Leveling in Minnesota. 1897 to 1910. 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

BULLETIN 453

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IN MINNESOTA

1897 TO 1910, INCLUSIVE

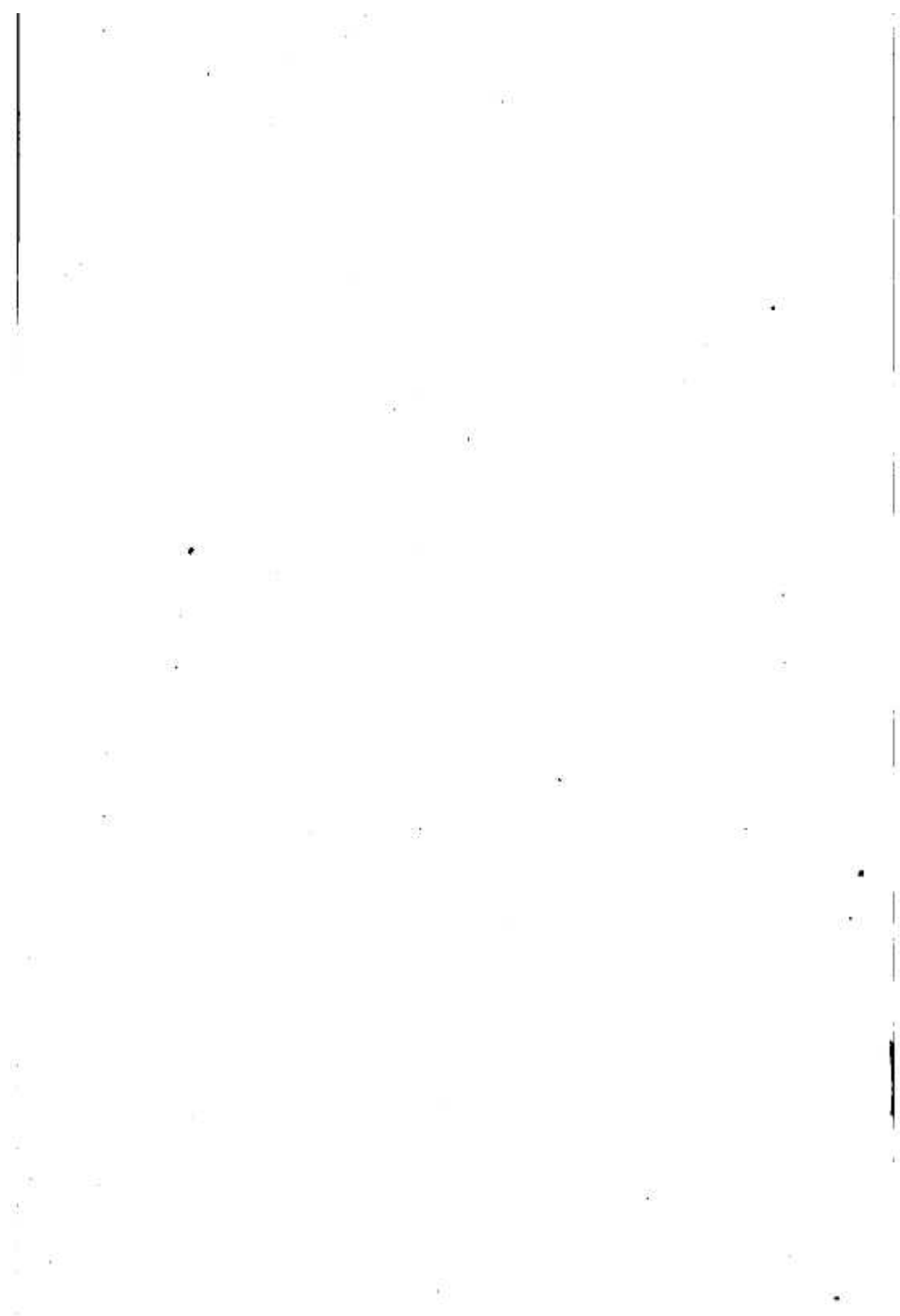
R. B. MARSHALL, CHIEF GEOGRAPHER

WORK DONE IN COOPERATION WITH THE STATE OF MINNESOTA
DURING 1909 AND 1910



WASHINGTON
GOVERNMENT PRINTING OFFICE

1911



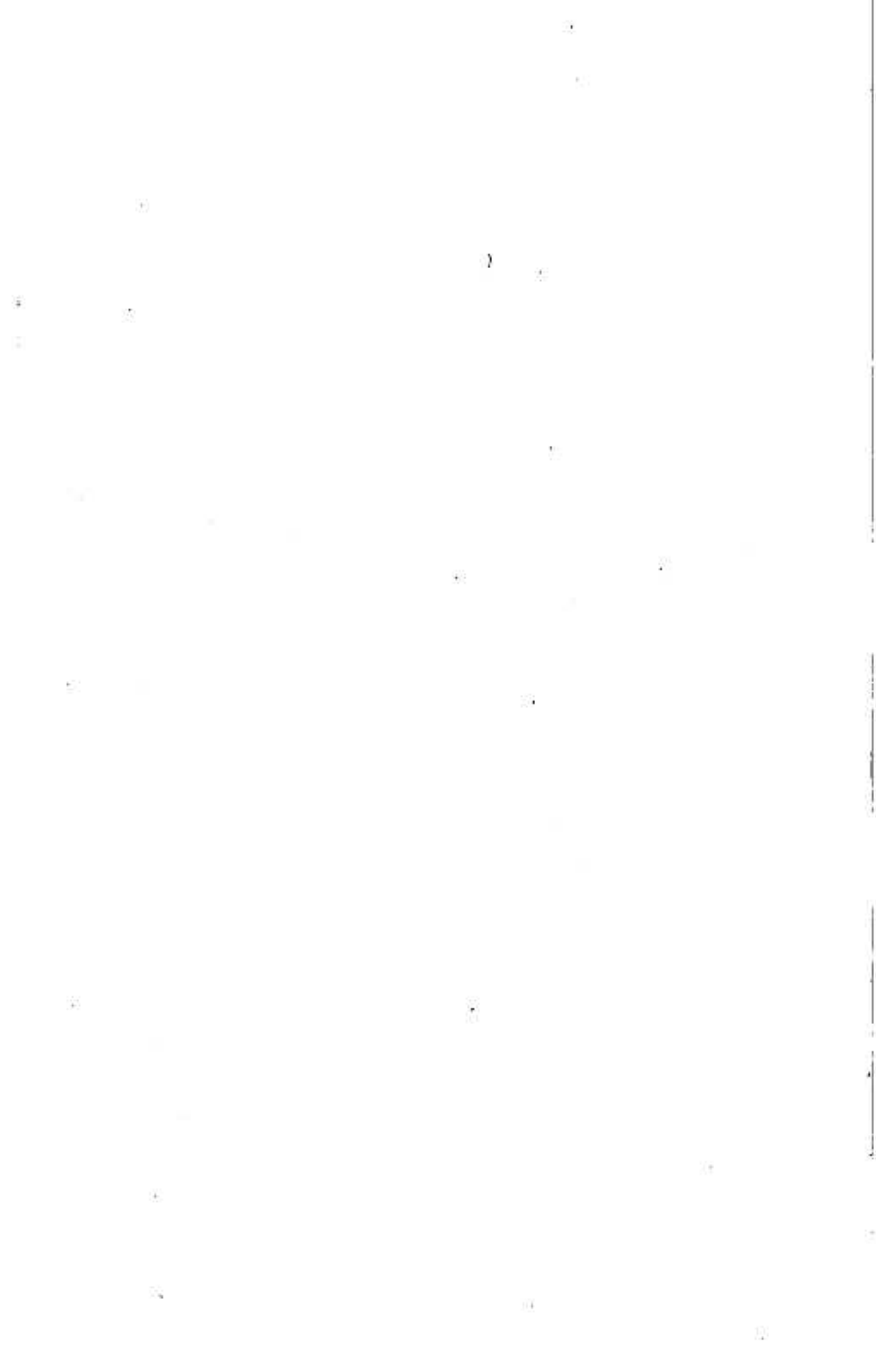
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RESULTS OF SPIRIT LEVELING IN MINNESOTA, 1897 TO 1910, INCLUSIVE.

R. B. MARSHALL, *Chief Geographer.*

INTRODUCTION.

Scope of the work.—All results of spirit leveling in Minnesota previously published by the United States Geological Survey and all the results of later work in the State are included in this report, rearranged by quadrangles. All elevations are based on the precise-level net adjustment of 1907 by the United States Coast and Geodetic Survey to a common mean sea level datum. The part of this net which lies within or along the borders of Minnesota comprises the line along Mississippi River from the southeast corner of the State to Lake Itasca, the line from Brainerd via Aitkin and Grand Rapids to Cass Lake, the line of the Corps of Engineers, United States Army from St. Paul to Duluth, and also the following lines by the Coast and Geodetic Survey: St. Cloud via Evansville and Childs to Ortonville, and Evansville via Fergus Falls and Crookston to Stephen.

Personnel.—The field work previous to 1903 was done under the general direction of J. H. Renshawe, geographer; that for 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. Credit is given to the different levelmen 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 in both forward and backward directions, 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 Y 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), $3\frac{1}{4}$ 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, 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 $3\frac{1}{4}$ inches in outer diameter and 4 feet in length after being split at the bottom and expanded 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, 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 of an inch in diameter.

The tablets as well as the caps on the iron posts are appropriately lettered, and for cooperating States the fact of such cooperation is indicated by the addition of the State name (at 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 $\frac{3}{8}$ -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