U. S. DEPARTMENT OF COMMERCE
Jesse H. Jones, Secretary

COAST AND GEODETIC SURVEY
Leo Otis Colbert, Director

MAGNETIC OBSERVATORY RESULTS AT SAN JUAN, PUERTO RICO FOR 1926-28

LOUIS HURWITZ
and
H. HERBERT HOWE

MO-16

Issued by the U. S. Coast and Geodetic Survey
Washington, D. C.
1943

CONTENTS

EXPLANATORY TEXT

TABLES

ILLUSTRATIONS

MAGNETIC OBSERVATORY RESULTS AT SAN JUAN, PUERTO RICO, FOR 1926-28.

INTRODUCTION

A magnetic observatory known as the Porto Rico Magnetic Observatory was maintained on Vieques Island, near Puerto Rico, from March 1903 to October 1924, both dates inclusive. Conditions became unfavorable, especially living conditions, and the owners of the property were disinclined to renew the lease. Accordingly, R. J. Auld, hydrographic and geodetic engineer, was instructed to find a new location on the Island of Puerto Rico. On account of the prevalence of volcanic formations, the number of places suitable for a magnetic observatory was limited. Finally, a site belonging to the city of San Juan was chosen, and a long-term lease was obtained. The grounds are located near the top of a hill about 10 kilometers south of San Juan and on the highway from San Juan to Guaynabo. The position of triangulation station OBSERVATORY on the observatory grounds (see figure 1) is, on the Puerto Rico datum,

Latitude: 18° 22' 53.456" North

Longitude: 66° 07' 04.618" West

The elevation of the triangulation station is 97.8 meters.

BUILDINGS AND CLIMATE

The observatory buildings were erected during 1925, and the instruments were installed that same year. The record began with January 1, 1926. The buildings were of wooden construction on concrete foundations. Although the variation building was fairly well insulated against temperature changes, it was not effectively protected against the extreme humidity of the region.

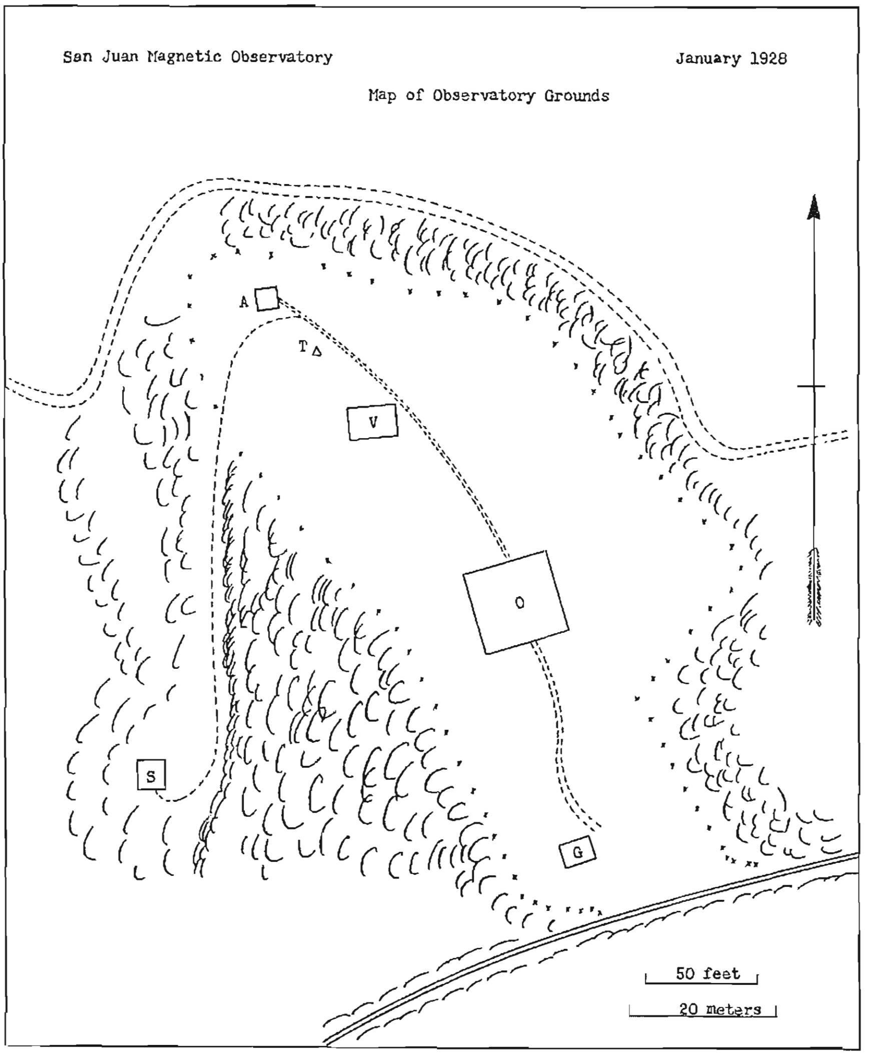
On September 13, 1928, a great hurricane destroyed the office building and its contents; but the variation and absolute buildings, though damaged, remained standing and the magnetograph was put back in operation September 24.

Figure 1 shows the general arrangement of the office, variation observatory, and absolute observatory before the hurricane of September 1928.

Soon after the magnetograph was placed in operation at San Juan, its performance became erratic and unsatisfactory because of the effects of the climate on the variometers. The warm, moist, salty air is favorable to corrosion and the growth of molds. There are gaps in the record because of these effects, because occasionally there was inadequate control due to lack of absolute observations, and because of the effects of the hurricane of September 1928.

PERSONNEL

The work of the division of geomagnetism and seismology (known before 1940 as the division of terrestrial magnetism and seismology) of the United States Coast and Geodetic Survey includes the office, field, and observatory work. Other magnetic observatories operated by this Bureau during the triennium were at Cheltenham, Maryland; Honolulu, Territory of Hawaii; Sitka, Alaska; and Tucson, Arizona.



A Absolute building
T Triangulation station
V Variation building

O Observer's quarters
G Garage
S Seismograph house

Fig. 1.

During the period covered by this report, N. H. Heck, hydrographic and geodetic engineer, was chief of this division. The work of the observatory was successively in the charge of R. J. Auld, hydrographic and geodetic engineer, until March 1926; W. M. Hill, magnetic observer, until September 1928; and Eoline R. Hand, hydrographic and geodetic engineer, through the end of 1928. F. Neumann, G. Hartnell, and H. E. McComb, magnetic observers, made adjustments at various times in attempts to overcome the instrumental difficulties which developed. Most of the office computations were made some years ago under the direction of D. L. Hazard, chief magnetician (now retired), assisted by the office staff, and the data were assembled by the writers.

WORK IN ALLIED FIELDS

Seismology.--A Bosch-Omori seismograph of two horizontal components was kept in operation until the time of the hurricane in September 1928. The results have already been issued.[1]

DESCRIPTION OF INSTRUMENTS

Variation instruments.--The magnetograph used during 1926-28 was of Eschenhagen pattern and consisted of a recording apparatus and three variometers which recorded, respectively, changes in magnetic declination (D), horizontal intensity (H), and vertical intensity (Z). The variometers are identified as Schulze no. 25 (D), Toepfer no. 10 (H), and, until August 1927, Schulze no. 20 (Z). In August 1927 Z variometer no. 20, was replaced by Schulze no. 21. The variometers were west of the recorder and upward motions of the curves correspond to increasing west declination, increasing H and decreasing Z.

The recorder first in use was Toepfer no. 5. In August 1927 recorder Schulze no. 5 was placed in operation. The time scale on the magnetograms was provided by hourly breaks in the base lines and in any trace which happened to be near a base line. These breaks were made by an occulting device controlled from the recorder driving clock; the mechanism often failed.

The error in the time marks was ordinarily determined each day by timing some of them with a chronometer. There is also for each trace an "overlap" error; i.e., each point on a trace is laterally displaced from the perpendicular line through the corresponding point of its base line. Corrections for these two errors are necessary in determining the times of salient points of the trace and in scaling hourly means during rapid changes.

Temperature of the magnetograph.--Temperature variations were recorded photographically by means of the thermograph built into the Z variometer. In addition both the Z and H variometers had thermometers which were read several times daily. The daily temperature range was usually small and it was not always necessary to use the photographic temperature trace to get magnetograph temperatures. Instead, for part of the period, temperature was determined by interpolation between thermometer readings. Table 1 shows the monthly and annual extreme and mean temperatures for the period 1926-28.

Humidity control.--In October 1927 all the variometers were equipped with drying tubes in an effort to control the effects of moisture. Mechanical disturbances of the variometers sometimes occurred when the tubes were refilled with the calcium chloride used as a drying chemical. In December 1928 the method of attaching the drying tubes was changed, so that there was much less mechanical disturbance of the variometers when the tubes were inspected or refilled.

Absolute instruments.--Magnetometer no. 31, of the India Survey pattern, was used for observations of declination and horizontal intensity. Until July 1927, earth inductor no. 106, of the Carnegie Institution of Washington pattern, was used for observations of dip; beginning with December 1927, Schulze earth inductor no. 1 was used.

CONSTANTS OF THE MAGNETOGRAPH

EFFECTS OF SHRINKAGE

It has long been recognized that magnetograms undergo appreciable variations in their dimensions; the principal change is attendant on the photographic processing of the record. No correction for shrinkage complete because of the numerous gaps in the record; however the table covers numerous periods for which the record was not controlled by base-line value observations.

The disturbances are divided into four classes from 1 to 4 according to relative severity, class 4 being reserved for storms of the most violent type.

Because of the widely varying scale values, it was impossible to preserve a standard of disturbance based upon appearance of the grams. The adopted method was to show graphically the periods counted as disturbed for Cheltenham and Honolulu, as a guide to determining varying standards for appearance of disturbed grams. The classification has thus been unavoidably influenced by the results for those observatories.

Magnetograms showing principal magnetic storms are reproduced in figures 2 to 12. A storm selected for reproduction is indicated in table 131 by an asterisk after the date. An upward motion of the curves corresponds to increasing west declination, increasing H, and decreasing Z.

NOTES AND REFERENCES

1. Inquiries regarding the availability and price of the reports should be addressed to the Director, U. S. Coast and Geodetic Survey, Washington, D. C.

2. For one demonstration that C must be included, see H. H. Howe, on the theory of the unifilar variometer, Terr. Mag., 42, 29-42 (1937), Section 20.

3. The formula for R was adapted from a formula computed in 1928 for this Bureau by the National Bureau of Standards.

4. H. H. Howe, op.cit., equations (7) and (26).

5. Daniel L. Hazard, Directions for Magnetic Measurements, (Serial 166), third (1930) edition, reprinted with corrections, 1938.

6. L. A. Bauer and J. A. Fleming, Land Magnetic Observations 1911-1913 and Reports on Special Researches: Researches of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, Vol. II, pp.270-273, 1915.

7. Commission de Magnétisme Terrestre et d'Electricité Atmosphérique, Caractère Magnétique de l'année 1926 (De Bilt, May 1927); Caractère Magnétique de l'année 1927 (De Bilt, September 1928); and Caractère Magnétique de l'année 1928 (De Bilt, July 1929).

8. Daniel L. Hazard, op.cit., p. 7.