

Brief History of Early Seismic Recording in Puerto Rico

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In the very beginning of the 20th century the U.S. coast and Geodetic Survey (USCGS) began the installation of a network of magnetic observatories. Many observatories also ran seismic equipment. The USCGS started with the principal magnetic observatory at Cheltenham, Maryland about 14 miles SE of Washington D.C. (Hazard, 1909). By the beginning of 1902 other observatories at Baldwin, Kansas, near Honolulu, Hawaii, and Sitka, Alaska were up and recording. Later, other observatories were installed in Tucson, Arizona, and Vieques, Puerto Rico. While the importance of establishing a magnetic observatory in the Caribbean was recognized, its installation was held to nearly last. The magnetic storm accompanying the 1902 eruption of Mt. Pelée on the Caribbean island of Martinique reinforced the need for a Caribbean magnetic observatory. The purpose of this note is to describe the history of the USCGS seismic equipment in the Caribbean, and to indicate the availability of records and reports be they originals, microfilm copies, or electronic images.

Physical Locations of Seismograph Stations VQS, SJP, and SJG

In February 1903 a temporary magnetic station was set up on the ground floor of Fort Isabel Segunda on Vieques a small island off Puerto Rico. It operated there until the spring of 1907 when all equipment was moved to a specially constructed building in Barrio Cofi about 5/8^{ths} of a mile west of the Fort. In September 1903 Bosch-Omori seismographs recording north-south and east-west motions were installed on stone piers in the Fort. The history and results of the seismographic station are reported in the US Coast and Geodetic survey (USCGS) reports "Results of Observations made at the Coast and Geodetic Observatory at Vieques, Porto Rico" from 1903- 1924. A history of the installation is given in the first Observatory report (Hazard, 1909); it includes photos, floor plan and the geographic coordinates of the station in the Puerto Rico datum.

A few further details of the site are given in the 1909 station site reports of the British of the Association for the Advancement of Science (1909):

"The floor of the room consists of 3 inches of cement underlaid with 3 inches of hard clay, which in turn is underlaid by stone. The piers, four in number, on which the seismograph parts are mounted are each 20 inches square by 32 ½ inches deep. Each consists of three pieces of dressed stone. These are laid in cement and extend 30 inches below floor-level; the space round each pier is filled with cement within 4 inches of the floor. The instrument consists of two pendulums recording north-south and east-west motion, It is possible to obtain the time of any effect within one or two seconds. The paper moves 15 mm. to the minute. The period of north-south pendulum is 26.36 seconds; east-west pendulum 24.7 seconds. The multiplication of the tracing points is 10." (Anon, 1909).

In the spring of 1907 the new facilities of the magnetic observatory were completed and equipment moved out of the fort and installed in the new observatory. Hazard (1911) reports on data for the years 1907 and 1908 and includes a description of the new facilities, including a plan of the grounds, and photo which includes a grazing cow for scale. The Bosch-Omori equipment operated there continuously until the observatory moved to the island of Puerto Rico at the end of 1924.

The listing of seismographic station of the world by Wood (1921) includes the following entry for the Vieques station:

“Porto Rico Magnetic Observatory, seismologic service inaugurated in September, 1903. Magnetic Observer, in charge, W. W. Merryman, present incumbent. U. S. Coast and Geodetic Survey. Postal address: Porto Rico Magnetic Observatory, Vieques, Porto Rico, or U. S. Coast and Geodetic Survey, Washington, D. C.; Latitude=18°08'50" N., Longitude=65°26'50" W., h=19.08 m;. Lithologic foundation: granitic rock overlaid with a few feet of heavy clay loam. Equipment: Bosch-Omori seismograph, mass 10 kg., two components N and E. Constants: V= 10, T_{ON} = 19 sec., TOE = 17 sec., 15 mm. = 1 minute. Time service: two box chronometers, corrections and rates determined by solar observations 3 or 4 times a month. The times of starting and stopping the record are noted daily by one of the chronometers and also the time of a mark made about the middle of a day's record. The seismograph clock, which makes a mark each minute on the smoked paper (1 minute = 15 mm.), is not of high grade, but when in good adjustment has a fairly uniform rate, so that the times of the minute marks are probably uncertain by not more than 5 sec.”

At the very beginning of 1926 the relocated Bosch-Omori seismometers were placed in operation at the new observatory in Guaynabo, just south of San Juan, Puerto Rico. The 1931 list of seismic stations (McComb and West, 1931) lists the following for the station now known as SJP:

“Station: San Juan. San Juan Magnetic Observatory, Box 3067, San Juan, Porto Rico, U. S. A.; Eoline R. Hand, Officer in charge; James W. Roberts, Assistant. 18° 23' N; 66° 07' W. 80 m. Broken limestone. Bosch-Omori, N and E, 1926 (Discontinued, 1928); Wenner, N and E, 1930. U. S. Coast and Geodetic Survey, Washington, D. C., U. S. A. Monthly Report; Earthquakes of the United States, Annual.”

A brief description of the new observatory, including a site plan, is found in Hurwitz and Howe (1943). The seismic station operated until a devastating Hurricane destroyed the observatory office and contents in August, 1928. We are not sure what happened to the seismic equipment, but so far we have been unable to locate station reports for the period 1926-1927.

Seismic recording was reestablished in 1930 with the installation of a pair of Wenner horizontals and a Benioff to record vertical motion. Charlier and Van Gils (1953) provide some instrument constants for the Wenner instruments. That station operated until the end of 1964 when a new station, SJG, was opened with WWSSN equipment in Cayey, Puerto Rico.

Table 1. Basic Station Parameters for VQS, SJP, and SJG

Station	Latitude	Longitude	Elevation	Dates of Operation	Instrumentation
VQS	18° 08.9' N (PR) 18° 08' 50.9" N	65° 26.4' W (PR) 65° 26' 20.8" W	40 m (PR) 42 m	9/7/1903- 3/18/1907	Bosch-Omori N, E
VQS	18° 08.8' N (PR)	65° 26.9' W (PR)	20 m (PR)	4/13/1907- 11/ 1/1924	Bosch-Omori N, E
SJP	18° 22' 53.436" N (PR)	66° 7' 4.618" W (PR)	97.8 m (PR)	1/1/1926 – 9/13/1928 ¹	Bosch-Omori N, E
SJP	As above	As above	As above	11/5/1930 – 12/1964	Wenner N, E; Benioff Z
SJG	18° 06' 42.0" N (PR40)	66° 09' 00.0" W (PR40)	457 m (PR40)	9/23/1964-	WWSSN

¹ Office building and contents destroyed in Hurricane, Bosch-Omori instruments and some records possibly destroyed at this time.

Note: PR is Puerto Rico Datum, PR40 is Puerto Rico datum, 1940 adjustment; other VQS coordinates are WGS84 datum. SJP coordinates are of triangulation site on the magnetic observatory grounds, seismograph station lies 65m SSW of there.

Location of Original seismograms

Copies of paper records (smoked records for the Bosch-Omori and photographic for the Wenner and Benioff instruments) were placed on microfilm as part of the records microfilm project of the mid 1980's (Glover at al., 1985). Some microfilms boxes are labeled SJP and are in fact VQS or vice versa. Investigators would be well-advised to use the recording year as the best guide to identify the correct station. Note also that Bosch-Omori as well as Wenner records exist for SJP, although for different time periods.

Original paper records from 1930 through 1964 were recently reorganized and made more accessible. They are presently available in Building 810 at the Denver Federal Center (DFC) in Lakewood, Colorado. Facilities exist on the DFC grounds for records scanning and copying digital data to CD-ROM. A detailed inventory of the paper records and microfilm copies and table notes are available by [clicking here and here](#). So far we have been unable to locate the original smoked-paper Bosch-Omori records of VQS/SJP from 1903-1927.

Table 2. Availability of Seismograms

Station	Paper Records	Microfilm	Electronic Images
VQS (1903-1924)	Unknown (lost?)	USGS (Golden, Menlo Park), RSPR	
SJP (1926-1927)	Unknown (lost?)	USGS (Golden, Menlo Park), RSPR	
SJP (1930- 1964)	USGS, Denver Federal Center	USGS (Golden, Menlo Park), RSPR	Selected local events 1930- 1932 and 1943-1946, IRIS (Seismoarchives)

Note: RSPR, Seismic Network of Puerto Rico

Reports with Station Readings

Hazard (1910) the USCGS report for the years 1905-1906 includes all the seismic readings from September 1903 through 1906. After that VQS readings appear in the USCGS reports (Hazard, 1910-1927) through data for 1924. Readings include component, date, arrival times of first P , second P, Large waves, maximum, end of principal portion, and event end, as well as maximum amplitude in mm. Starting with the data for 1915 VQS reports readings using the nomenclature of the International Seismological Association (ISA)². Notes at the end of each table indicate probable local earthquakes as well as locally felt events. The first earthquake reading is for an event on September 7, 1903 with origin either south of New Zealand or near Taiwan. The station was operational and readings are reported for the September 27, 1906 Puerto Rico earthquake, which was felt widely throughout the region, as well as the mainshock and aftershocks of the October 11, 1918 (7.3Mw) earthquake off northwest Puerto Rico. As part of an IASPEI sponsored program, all magnetic Observatory reports with seismic data for VQS have been scanned for the period 1903-1924.

² Arrival times of first preliminary tremors, beginning of second preliminary tremors, beginning of long waves of principal motion, time of greatest amplitude of motion, end of principal motion, end of principal portion, end of visible records, maximum amplitude or one half of the maximum range, giving actual movement on the stylus as measured on the seismogram.

Table 3. Availability of Station Reports for VQS and SJP

Station	Source	Start Date and End Date	Format, Location
VQS	USCGS Magnetic Observatory Report	September, 1903 – December, 1924	PDF, IRIS (Seismoarchives) Originals, NOAA/NGDC
VQS	US Weather Bureau	June, 1915 – December 1924	Microfilm, NOAA
VQS	USCGS Earthquake Report	January, 1919 March, 1919 – December, 1920 March, 1921 – May, 1921 September, 1921 – June, 1922 September 1923 – December, 1923 March, 1924 – November, 1924	Microfilm, NOAA
SJP	unknown	January 1, 1926 –December 31, 1927	unknown
SJP	USCGS Preliminary Reports	January 1928 - August 1928	Microfilm, NOAA
SJP	USCGS Seismographic Report	January 1930 – December 1940	Microfilm, NOAA
SJP	USCGS Seismological Bulletin	January 1941 - March 1951 January 1954 - December 1966	Microfilm, NOAA

Data for VQS and the other seismographic stations at magnetic observatories from 1925 onward were reported in quarterly Seismological reports of the USCGS. These are not the only reports for VQS, however. The U.S. Weather Bureau also reported data from numerous seismic stations. Seismogram readings are reported according to the nomenclature of the ISA noted above. In the Weather Bureau reports period and amplitude information are included so that event magnitude could be calculated using present-day standard formulas. Also comments on characters of the trace reading are also included, these two points may make the Weather bureau reports more useful and, therefore, important than magnetic observatory reports. VQS Weather Bureau reports from June 1915 through December 1924 were microfilmed as a part of the station bulletin microfilm project (Glover at al., 1985). Details of all known reports and their availability are in table 3. So far no SJP reports for 1926-1927 and April, 1951- December, 1953 have been identified.

References

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