RECORDS ADMINISTRATION
ABUX

ACC# 735157

DP-MS-80-1

SAVANNAH RIVER PLANT SEISMOGRAPH NETWORK*

by

C. W. Krapp

E. I. du Pont de Nemours & Co. (Inc.)
Savannah River Laboratory
Aiken, SC 29801

SRL
RECORD COPY

A paper proposed for presentation at the
South Carolina Academy of Science Meeting
Charleston, South Carolina
March 28-29, 1980

---

* This paper was prepared in connection with work under Contract No. DE-AC09-765SR00001 with the U.S. Department of Energy. By acceptance of this paper, the publisher and/or recipient acknowledges the U.S. Government's right to retain a nonexclusive, royalty-free license in and to any copyright covering this paper, along with the right to reproduce and to authorize others to reproduce all or part of the copyrighted paper.

SAVANNAH RIVER PLANT SEISMOGRAPH NETWORK*

C. W. Krapp

E. I. du Pont de Nemours & Co. (Inc.)
Savannah River Laboratory
Aiken, SC 29801

Introduction and Summary

Although Charleston is the epicentral location of 92% of the earthquakes that occur in South Carolina, earthquakes do occur in other parts of South Carolina. To record these events, which would be useful in assessing the seismic characteristics of the region, the Savannah River Plant (SRP) installed a seismograph network.

The SRP Seismograph Network became fully operational on August 6, 1976, and has recently completed its third year of nearly continuous operation; about twenty local seismic events, all minor, have been recorded. Local earthquake data are routinely exchanged with other workers. The first local earthquake, near Kline, South Carolina, was recorded and was analyzed in 1976. An apparent seismic event is discussed which is attributed to a shock wave, atmospheric interaction caused by a supersonic aircraft.

* The information contained in this article was developed during the course of work under Contract No. DE-AC09-76SR00001 with the U.S. Department of Energy.

Network Description

The network[1,2] consists of three field seismometer sites (SRPN, SRPW, SRPD) and one central recording station. The seismic activity at each field site is detected by a seismometer, which is a movable coil that induces a series of electric impulses when vibrated. These electrical impulses are amplified and sent over telephone lines to a central recording site, where the signals are again amplified and then recorded by a heated stylus on heat-sensitive paper. The locations of the three field seismometers and the central recording station are shown in Figure 1. A photograph of a seismometer in its small concrete vault is shown in Figure 2, and a photograph of the recording station is shown in Figure 3. The signals from sites SRPN and SRPW are fed directly to telephone lines, but the signal for SRPD is first transmitted by radio to the D-area powerhouse and then fed into a telephone line for transmission to the recording station. The signals from seismometer site SRPN are recorded at two different gains (high and medium) to permit different resolutions for earthquakes of different magnitudes.

Timing accuracy is provided to within 0.050 seconds, and times are compared daily with the National Bureau of Standards time which is broadcasted from Radio Station WWV in Fort Collins, Colorado. The time base for the network is Universal Time Coordinated (UTC), which is five hours later than Eastern Standard Time (EST) and four hours later than Eastern Daylight Time (EDT).

Operating Summary

The average monthly operating time for the network is shown in Figure 4 for the first 40 months. The average operating time for the network is 94%. Typically, two of the three sites were always operating. However, the entire network was out-of-service for 3 days due to a power supply failure.

The complexity of equipment at site SRPN caused its poorer performance relative to the other sites. A lightning strike, battery failure, electronic component failure, and intermittent telephone line problems were responsible for its performance.

Data Exchange

The three seismometer sites have received approved designations from the National Earthquake Information Service (NEIS) and are described in a *Historical Survey of U.S. Seismograph Stations*.[3] Data collected from the SRP network have been used to calculate preliminary magnitude and location of local earthquakes. The analyzed data is contributed every six months to the *Southeastern U.S. Seismic Network Bulletin* published by Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Data have been exchanged with other workers for mutual benefit. Copies of local earthquake records from the SRP network were provided to the U.S. Geological Survey — Branch of Earthquake Hazards to complement data collected from their South Carolina network. Similar data were provided to seismologists and graduate students at the University of South Carolina and the Georgia

Institute of Technology. Data collected from the SRP network have been used to confirm or deny citizens' reports of local earthquake activity.[4]

Local Earthquake and Analysis

A local earthquake was detected on September 15, 1976, at 05:15 UTC (1:15 AM, EDT) by two of the field sites. The third site was not operational due to a tilted sensor. The term "local earthquake" refers to an event located not more than 1000 km (621 miles) from the seismometer.[5] Large earthquakes at greater distances (teleseisms) are recorded, but are of casual interest only.

The arrival of the compressional (P) wave and shear (S) wave were recorded at both sites. The seismograms (Figure 5) indicate that site SRPW received the earliest response. The time interval between the arrival of S- and P-waves gives a measure of the distance to the epicenter of the earthquake. The arrival times and estimated distances to the epicenter from each site are listed on Table 1. Since only two sites were operating, a unique location cannot be found. The SRP locations for the earthquake would be in Burke County, Georgia, or Allendale County, South Carolina, 180° apart.

Discussions with the seismologist at the University of South Carolina, Columbia, South Carolina, confirmed the location of the epicenter in Allendale County, South Carolina, and indicated a magnitude of 2.5 on the Richter scale. The SRP Seismograph Network

gave a location near Kline, South Carolina, which correlated very well with the location determined by others using other seismographs.

Unusual Seismic Activity — Sonic Boom

On March 2, 1977, at 22:25 UTC (5:25 PM EST), an event with an amplitude equivalent to a local earthquake magnitude of $M_L = 3.0$ was recorded at all three sites of the SRP network. The event was first recorded at SRPD, then at SRPW, and finally, 53 seconds later, at SRPN. Because of the long elapsed time between seismometer sites, the event cannot be attributed to an earthquake, because seismic wave travel times would be between two and three seconds. However, an approximate wave velocity was determined using the distance from SRPD to SRPN and the arrival time difference. The wave velocity was calculated to be 430 m/sec (1,411 ft/sec) and compares very well (within 30%) with the speed of sound in dry air. This agreement suggests the event was a sound wave which first arrived at SRPD near the Savannah River and traveled northeasterly across the plant to SRPW and finally to SRPN.

Sound waves are produced by aircraft shock wave — atmosphere interaction, commonly referred to as a sonic boom.[6] This noise is produced by a change in atmospheric pressure characterized by a rapid compression, slow expansion, and a rapid compression. Depending on the size and speed of the aircraft, the two compressions (or booms) may not be discernible by the observer.

Ascribing this March 2, 1977, event to a sonic boom was only partially confirmed. Personnel[7] at the Barnwell, South Carolina airport hangar observed a loud thump with subsequent vibration of the hangar for ∿1 minute on March 2, 1977, between 5:00 and 6:00 PM EST. A jet was heard overhead probably flying at 9,000 to 12,000 m. SRP patrol did not report any aircraft overflights and no loud noises were heard. Queries to civilian and military flight controllers produced no records of supersonic flights.

References

1. C. W. Krapp. "Savannah River Plant Seismograph Network." Article 14 in *Savannah River Laboratory Environmental Transport and Effects Research — Annual Report 1976*. USERDA Report DP-1455, E. I. du Pont de Nemours & Co., (Inc.) Savannah River Laboratory, Aiken, SC (1977).
2. C. W. Krapp and D. E. Stephenson. "SRP Seismograph Network Operations August 6, 1976 to August 31, 1977." Article 14 in *Savannah River Laboratory Environmental Transport and Effects Research — Annual Report 1977*. USDOE Report DP-1489, E. I. du Pont de Nemours & Co., (Inc.), Savannah River Laboratory, Aiken, SC (1978).
3. B. B. Poppe. "Historical Survey of U.S. Seismograph Stations." *Geological Survey Professional Paper 1096* p 283 (1979).
4. B. Henshaw. "Scientists Debunk Earth Tremor Rumor." *Augusta Chronicle*, p 2B (Friday morning, March 4, 1977).

5. C. F. Richter. Page 16 in *Elementary Seismology*. W. H. Freeman, San Francisco, CA (1958).

6. H. H. Hubbard. "Sonic Booms." *Physics Today, 21 (2)* 31 (1968)

7. R. J. Sand. Personal communication; March 4, 1977.

LIST OF TABLES

1 Analysis of September 15, 1976, Earthquake Recorded on the SRP Seismograph Network

LIST OF FIGURES

1 Savannah River Plant Seismograph Network

2 SRP Seismometer in Field Location

3 SRL Seismic Recording Station

4 Plot of the Average Monthly Operation for the SRP Seismograph Network

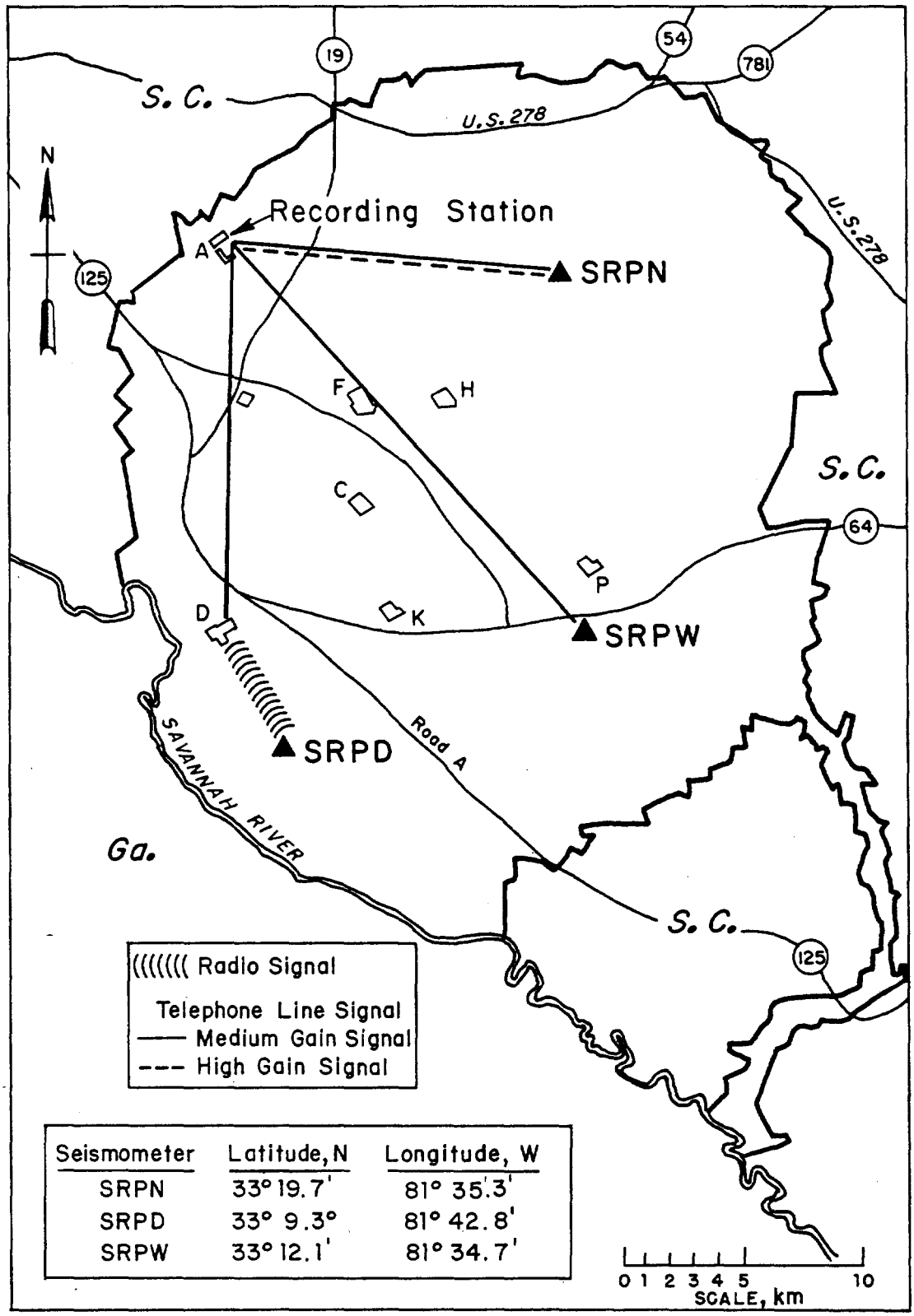
5 Seismic Tracings of September 1976 Earthquake

TABLE 1

Analysis of September 15, 1976,
Earthquake Recorded on the SRP Seismograph Network

Site		*Arrival Times, UTC*		*S − P, sec*	*Distance to Epicenter, km**
		P-Wave	*S-Wave*		
SRPN	(High Gain)	05:15:40.0	05:15:43.5	3.5	29.8
	(Medium Gain)	05:15:40.3	05:15:43.7		
SRPD	(Medium Gain)	Geophone tilted; seismograph inoperative			
SRPW	(Medium Gain)	05:15:39.0	05:15:41.0	2.0	17.0

* Dependent on crustal model used; assumed 8.5 km/sec between arrival of the S-wave and the P-wave.



Seismometer	Latitude, N	Longitude, W
SRPN	33° 19.7'	81° 35.3'
SRPD	33° 9.3°	81° 42.8'
SRPW	33° 12.1'	81° 34.7'

FIGURE 1. Savannah River Plant Seismograph Network

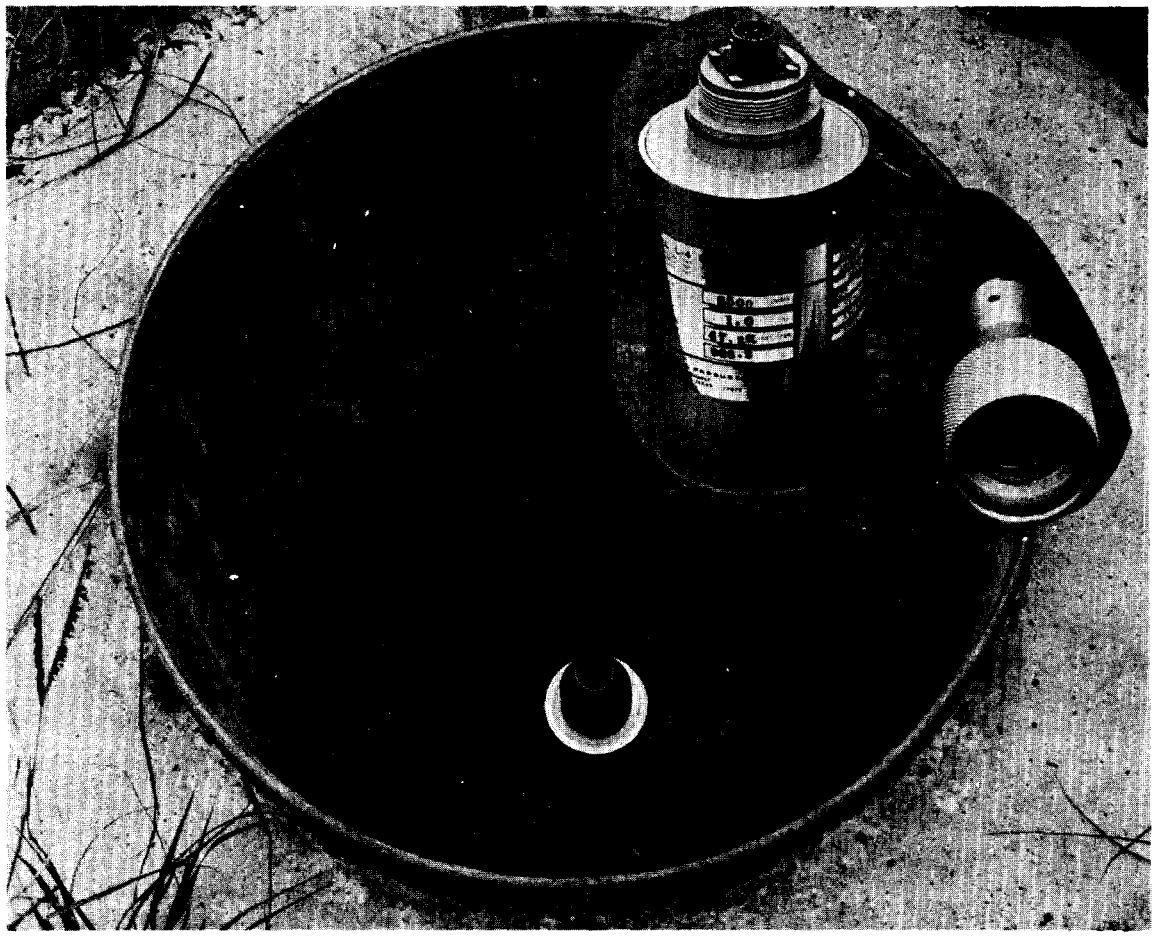


FIGURE 2. SRP Seismometer in Field Location

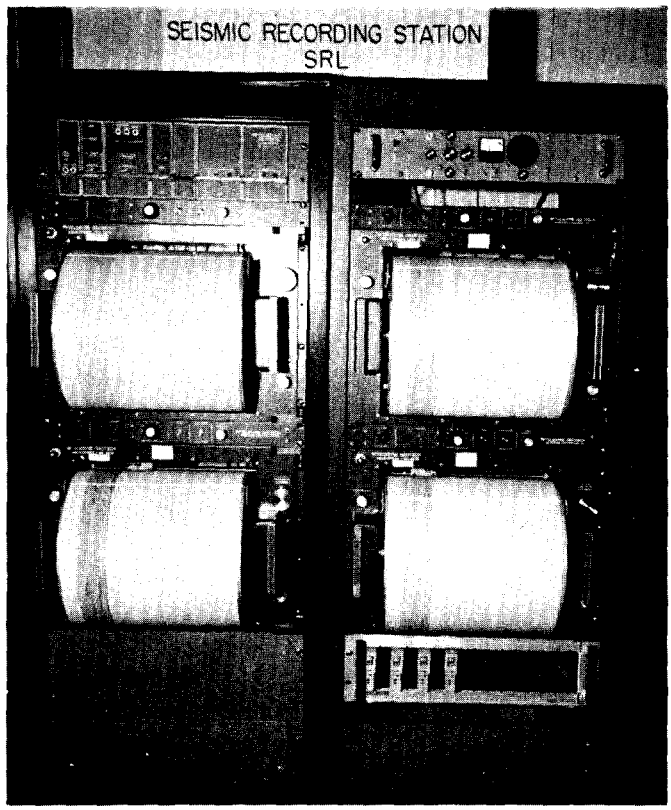


FIGURE 3. SRL Seismic Recording Station

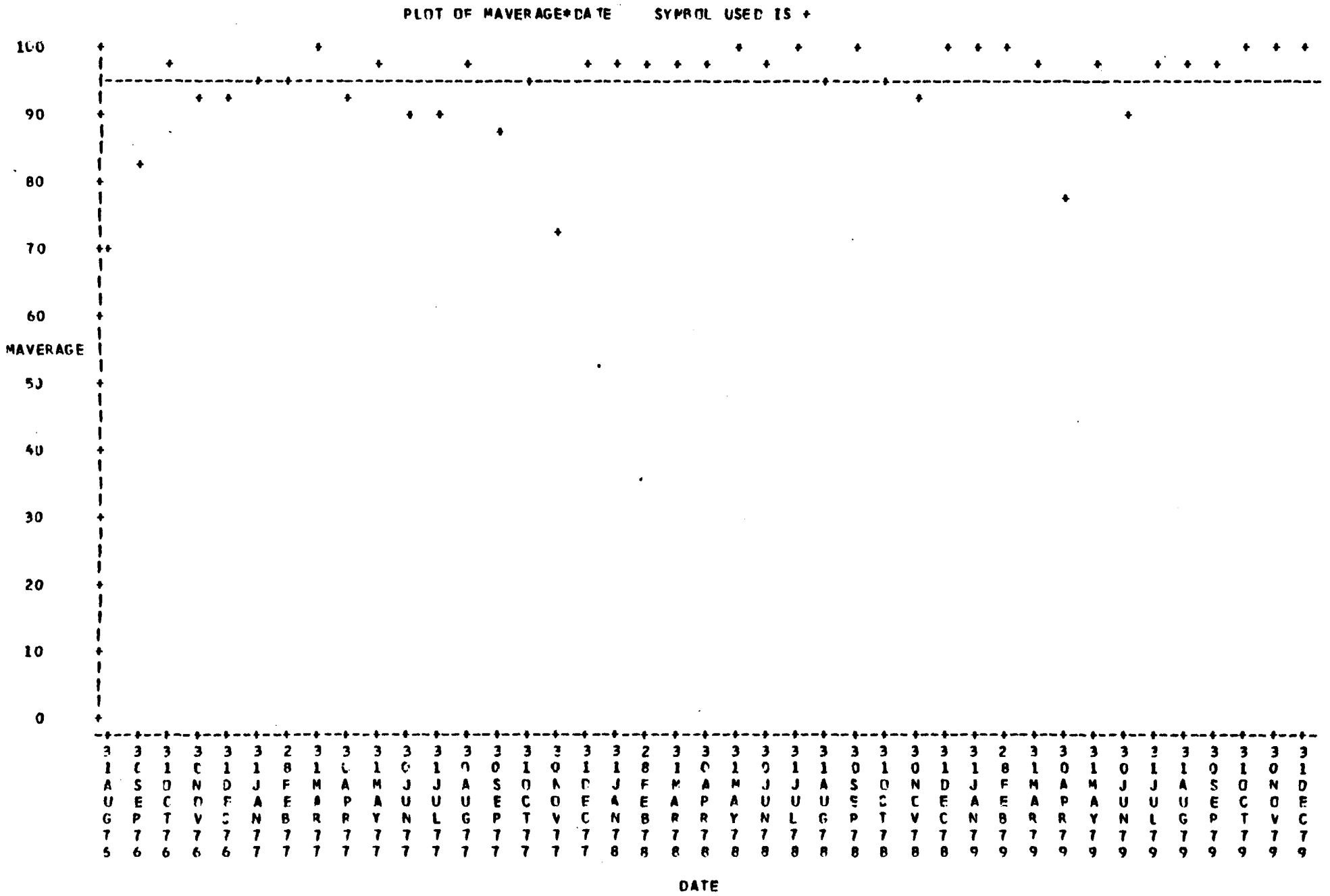


FIGURE 4. Plot of the Average Monthly Operation for the SRP Seismograph Network

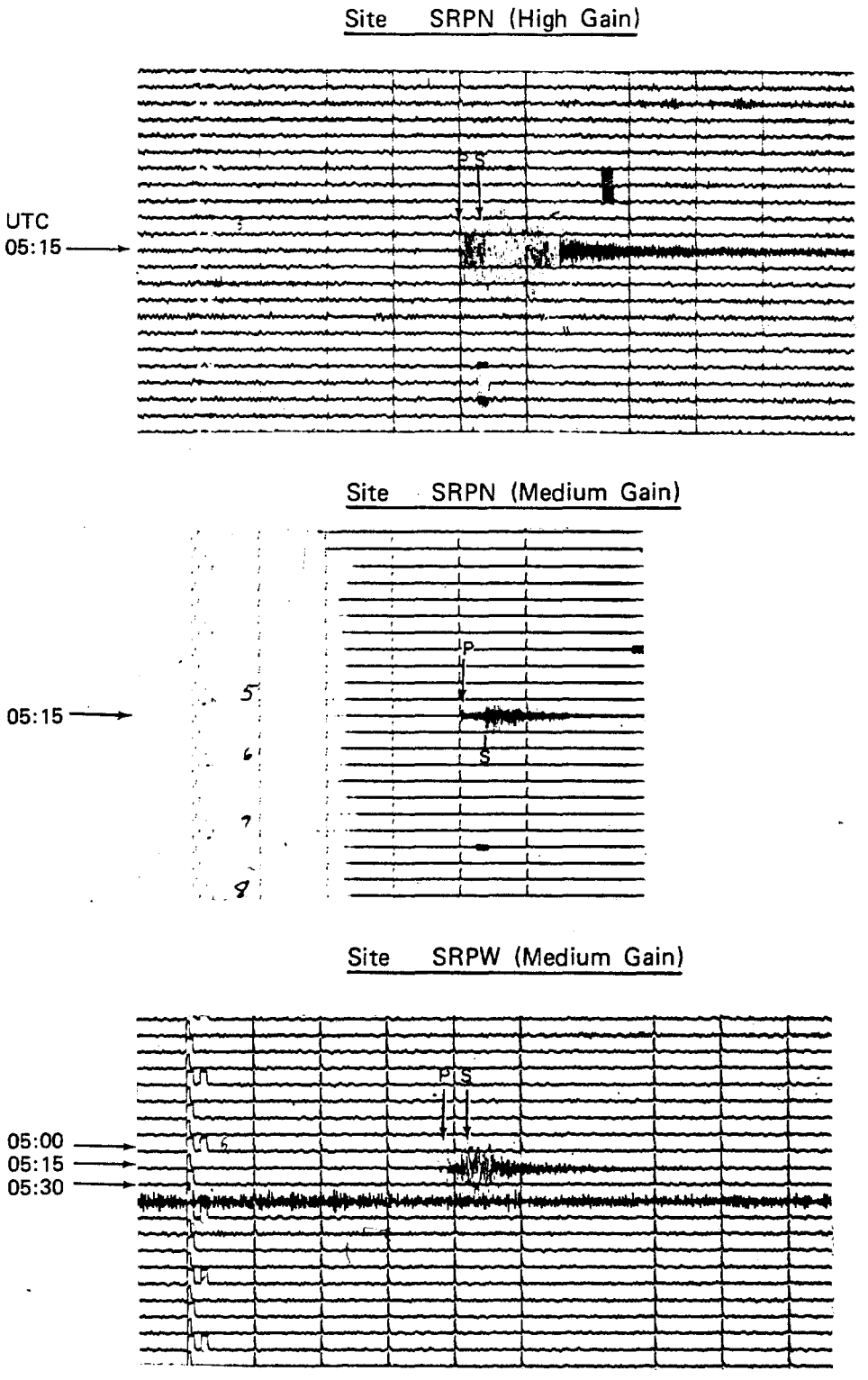


FIGURE 5. Seismic Tracings of September 1976 Earthquake