Workshop W-2

EARTHQUAKE WORKSHOP

Frank Revetta
SUNY Potsdam

Saturday, September 18, 2004
Room 120 Timerman Hall

Morning

8:00A.M. -9:30A.M.	Potsdam Seismic Network and earthquakes in northern N.Y.
09:30A.M. - 12:00Noon	Field trip to Potsdam and Lake Ozonia seismic field stations.

Afternoon

01:00P.M. - 5:00P.M.	Field trip A-8 to Massena, New York, site of largest earthquake in New York State on September 5, 1944.

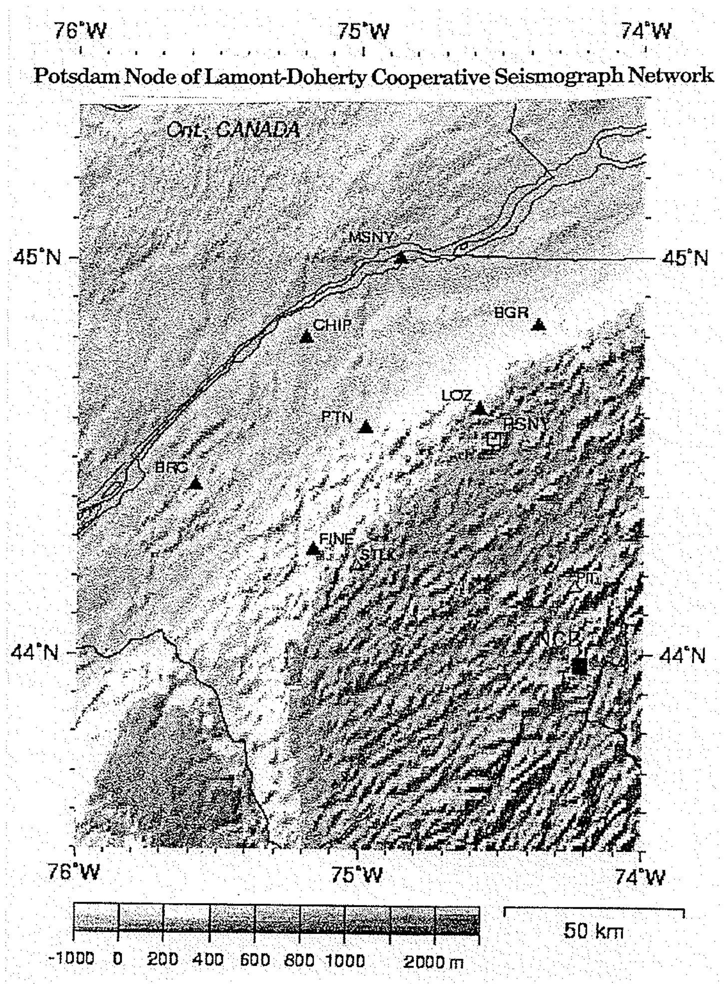

Figure 1. Location of seismic stations in Potsdam Network.

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I. LCSN Seismographic Stations

The locations of the Nodes of the LCSN are shown in Figures 1 and 2. The Potsdam Node is located in the St. Lawrence Valley of northern New York and lies in the heart of the northern New York-Western Quebec Seismic Zone. This is the most active seismic area in New York State. The other nodes are Palisades at Lamont Doherty Earth Observatory, Delaware Node at Delaware Geological Survey – University of Delaware, and Lake Champlain Node at Middlebury College, VT. These stations monitor earthquakes that occur primarily in the Eastern United States.

II. History of the Potsdam Seismic Network

The Potsdam College Seismic Network consists of seven short period-vertical seismograph stations located in the St. Lawrence Valley in northwestern New York (Figure 1). The first station (PTN) was installed in October 1971 as a joint venture between Potsdam College and the Lamont-Doherty Geological Observatory (LDGO) of Columbia University. LDGO installed the seismic filed station ten miles south of Potsdam and telemetered the seismic signals to Potsdam College where they were recorded on a seismograph jointly purchased by the Potsdam College and Alcoa Foundations. The seismic signals were transmitted by telephone lines to LDGO at Palisades, New York, for study by the LDGO seismologists. This was the first seismograph station installed in northern New York.

During the succeeding years, six more seismograph stations were installed in the area. In 1976 LDGO installed seismic field stations at the Long Sault Dam at Massena, New York, and at Bangor, New York. The Gulf and Alcoa Foundations provided Potsdam College with grants to purchase seismographs to record from these two field stations. From 1983 to 1988 Potsdam College purchased seismic equipment to install three stations at Lake Ozonia (LOZ), Star Lake (STLK) and Brasie Corners (BRC). The funds for the installation of these stations were received from the New York State Power Authority and Alcoa Foundations. In 1988 Plattsburgh State College donated one seismograph to Potsdam College. In addition, the Lamont-Doherty Geological Observatory has provided much detection and telemetering equipment.

In 1977 the Star Lake Station (STLK) site was moved to Fine, N.Y. In 2000 a three component broadband station was installed at the Lake Ozonia site (LOZ). The earthworm software was also installed, which enables us to study seismic data in the LCSN network from stations outside our Potsdam Network.

III. Seismic Field Stations

The detection of earthquakes occurs at the seven seismic field stations shown in Figure 1. The instrument that detects the ground motion produced by an earthquake is the seismometer (Figure 4). The seismometer is a coil of wire that is free to move back and forth in a magnetic field. All the seismometers are vertical short-period units which respond to the short-period seismic waves generated by local earthquakes. The seismometer is placed on bedrock inside a bottomless 55 gallon steel drum. The ground motion produced by the seismic waves is converted to an electrical signal and fed into a high-gain amplifier to increase the signal amplitude (figure 5). This signal is frequency modulated by a voltage-controlled oscillator (VCO). The VCO frequency is now in the audible range and its output frequency changes in response to the change sensed by the seismometer. The signal is modulated to the FM radio transmitter and then transmitted to the receiving station at Potsdam College. The power output of the transmitter is 100-350 milliwatts. The frequency is usually in the UHF government experimental band, however, a clear channel VHF frequency may be used for more critical propagation problems.

All stations are solar powered (Figure 6) except MSNY and PTN. The solar-powered station consists of a silicon solar collecting panel that provides DC current to the regulator during the daylight hours. When sufficient current is available, a regulator recharges the battery. The battery supplies the energy that is needed to power the radio transmitter. This results in a significant financial savings.

IV. Seismic Recording Stations

All seven of the seismic stations transmit the seismic signals to Potsdam College via FM narrow band telemetry except the station at Fine, N.Y., which is relayed through the Brasie Corners station (BRC). Antennas and receivers on Raymond and Timerman Halls pick up the signals and feed them into discriminators (Figure 7). The discriminator removes the FM carrier wave and feeds the signal into the amplifier for amplification. The output from the amplifier is recorded on the helicorder or seismograph.

The output from the discriminators also enters a computer which serves as an analog to digital converter. The computer supplies the digital information for the purpose of having a permanent record of all seismic events that have been detected by our network. This information is forwarded to the Lamont-Doherty Earth Observatory for study by their seismologists.

The entire system is "locked on" to a satellite receiver, which continuously monitors a GOES satellite, which transmits time signals from the National Bureau of Standards at Washington, D.C. The clock displays the number of the day and of the year, and hours, minutes and seconds in Universal Coordinated Time (UTC). Its accuracy is always within 12 milliseconds of true UTC time. The Potsdam College Seismic Network short-period seismometers are best suited for the detection of local earthquakes. Local earthquakes are those with epicenters within 1000 kms from the seismic station. However, distant earthquakes (teleseisms) may also be recorded provided the magnitude of the earthquake is greater than 5 on the Richter Scale.

Table 1 shows station data for the seismic field stations of the Potsdam Network. The first column lists the station code. Presently we are recording from 7 field stations including a broadband three-component station at Lake Ozonia (LOZ). The Pitcairn (PIT) and Star Lake (STLK) stations have been closed. The latitude, longitude and elevation of each station is listed and their date of installation. The landowners of the station sites are listed below. We are grateful for their willingness to let us install the stations on their land.

John Fife	CHIP	315-322-5669
John Colt	PTN	315-265-9168
Raymond Hays	BRC	315-578-2535
Roger Fraser	FINE	315-848-2880
Bruce Monette	BGR	518-483-3835
Root Parker	LOZ	418-856-9277
N.Y Power Authority	MSNY	315-764-0226

V. Broadband Station

A three component broadband seismometer was installed at the Lake Ozonia Site in 2000. The seismometer rests on Precambrian bedrock. The instrument is well insulated. The station is located at a quiet site away from any extraneous noise. The station is solar powered with several solar panels to keep the batteries fully charged. Output from the broadband sensor is digitized with the digitizer and fed into a radio transmitter and antenna for transmission to Potsdam College. These signals are picked up by a radio receiver and fed into a PC with Windows NT running Earthworm and also into the Internet.

VI. Earthquakes in Northeastern United States

Most of the epicenters recorded by the Potsdam Network are located in northern New York in a seismic zone called the Northern New York-Western Quebec Seismic Zone. The Potsdam Network is located in the center of these epicenters. The epicenters trend northwestward, the same direction as fault plane solutions of the earthquakes. Most of these earthquakes are shallow and have their foci in the upper 8 kms of the Earth's crusts. No major fault is known to trend across the area and no surface faults have been observed that can be related to the epicenters. It is likely that the earthquake foci are due to reactivation of shallow fractures that do not reach the surface.

VII. Intensity Studies

Intensity surveys are conducted of the larger earthquakes (Mc 4-6) that are felt over a widespread area. The United States Geological Survey Earthquake Report is distributed to residents, schools, and news media throughout the area. Evaluation of the responses enables intensity at particular sites to be determined with the Modified Mercalli scale. The intensity values are plotted and contoured to construct an isoseismal map of the earthquake.

VIII. Applications of the Potsdam Seismic Network

The Potsdam Seismic Network provides significant services to the general public, education and research. The network keeps the people of the New York and eastern Canada informed about earthquakes in the area. The occurrence of an earthquake is verified by the network, and the location of the epicenter and magnitude are reported to the news media. The network helps to distinguish for the public whether the seismic event is an earthquake, quarry or mine blast, sonic boom or cryoseism. The college receives much publicity from the many calls and information provided to the news media after the occurrence of a local earthquake. A seismicity report is published listing all the earthquakes recorded during the year. Earthquake information in the area is also available over the internet at the web site: http://www.ldeo.columbia.edu/lcsn. This website lists the current earthquakes recorded as well as information about the network and earthquakes.

The network provides a valuable link between the college and other universities, government agencies and industries. The Potsdam Node is part of the larger Lamont-Doherty Seismic Network. We work closely with LCSN on the maintenance, repair and operation of the network to provide information about the seismicity of the region that will help us better understand the seismic hazard in the area. A close working relationship also exists with the Canadian Geological Survey and its Seismology Division, which includes a mutual exchange of the earthquake data. We also work closely with the New York State Geological Survey which has provided us with 7 portable seismographs for education use and for research dealing with aftershocks and crustal structure studies. Local industries and residents have also supported the network by providing funds for operation costs. The New York Power Authority provides funds for operational costs and the college supports its operation in its budget. A special thanks goes to Mrs. Valere Ricaud of Massena, N.Y. for her support of the network each year.

The seismic network provides services for education and research of our students. The seismograms of earthquakes recorded by the network are used to teach students seismogram interpretation in Seismology, Earth Science, Environmental Geology and Physical Geology courses. During the school year the network is operated, repaired and maintained by our students. They have the responsibility of changing the records and seismogram analysis to locate the epicenter of earthquakes. They often use the seismic data for undergraduate research projects and usually present their research projects at the Geological Society of America Meeting and Science Fair at the college. A number of undergraduate research topics are made possible by the network. Curstal structure studies by using the network data and portable seismographs given to us by the N.Y. State Geological Survey are in progress. Induced sesimicity studies caused by water accumulation in closed mines have also been conducted.

IX. Where do I acquire information about earthquakes in northern New York?

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Sylvia Lehmann
Email: lehmann@seismo.nrcan.gc.ca

Internet: http://www.seismo.nrcan.gc.ca

Lamont-Doherty Earth Observatory LCSN
http://www..ldeo.columbia.edu/LCSN

The Canadian Geological Survey lists all the current local earthquakes and monthly reports. The Lamont-Doherty Cooperative Seismographic Network (LCSN) lists all current earthquakes in Eastern United States and view of current seismograms.

The website for the National Earthquake Information Center NEIC is excellent for worldwide earthquake information. It is certainly worth accessing and exploring. The website is: http://www.neic.cr.usgs.gov/

The Lamont-Doherty Seismographic Network (LCSN) webpage:
http://www.ldeo.columbia.edu/lcsm/eus.html
This web page contains information such as an earthquake catalog, seismicity map, selected recent earthquakes in eastern United States, and other web sites for earthquakes in the Eastern United States.

X. Future Plans

Two more seismic stations are planned in the immediate future. A short period vertical seismometer is being installed at Mt. Arab, New York about 40 miles southwest of Potsdam. The seismic signals will be transmitted to Potsdam via an FM radio transmitter. This station is located near Tupper Lake, N.Y. and serves to expand the network toward the southeast.

A short period 3 component station is also being installed in the basement of Timerman Hall. The 3 component instrument will provide a complete record of the ground motion of local quakes and make possible more accurate locations of hypocenters of earthquakes.

MORNING FIELD TRIP

Stop I Potsdam Seismic Station (PTN)

This station was installed in October 1971 as a joint venture between Potsdam College and the Lamont-Doherty Earth Observatory. LDEO installed the seismic field station ten miles south of Potsdam and initially used telephone lines to transmit the signals to Potsdam College where the traces were recorded on a seismograph. The seismic signals were also transmitted to LDGO at the Palisades, N.Y. by telephone lines which eventually proved too expensive to operate. Later the signals were transmitted by high frequency radio transmitters to Potsdam College and to LDGO through the internet.

This station is a short period vertical seismometer best suited for detection of local earthquakes. The output from the seismometer is fed into a high gain amplifier to increase the signal amplitude. The signal is frequency modulated by a voltage-controlled oscillator (VCO). The VCO frequency is now in audiable range and its output frequency changes in response to the change sensed by the seismometer. The signal is sent to the FM radio transmitter to transmit to the receiving station at Potsdam College.

The seismometer is mounted on Precambrian gneiss bedrock which produces the optimum signal. A site should be located on bedrock and away from any noise. The site must also be at an elevation so the line of sight enables the signal to be received at Potsdam. This site is powered by batteries since there are too many trees in the area to use solar panels.

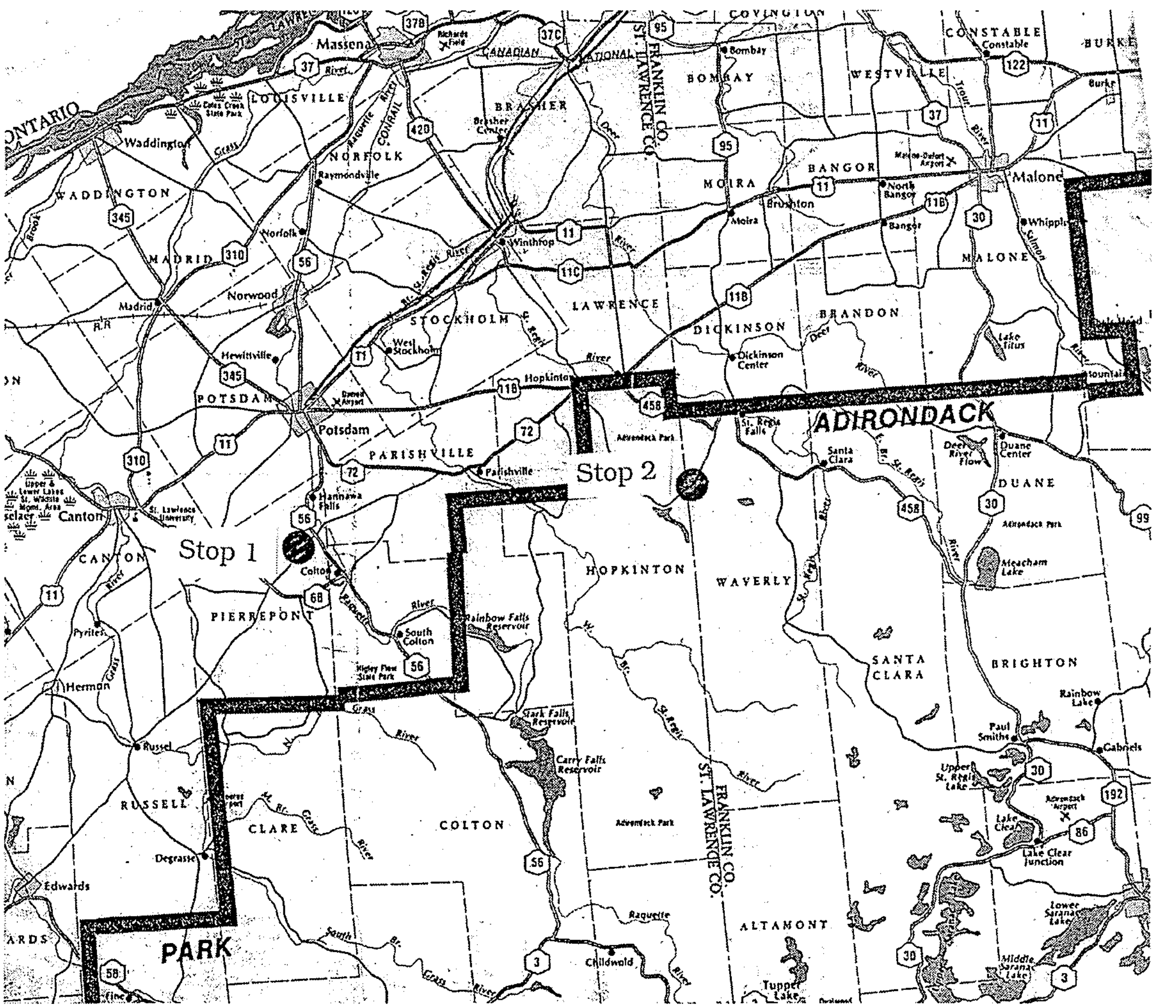

Figure 2. Location of morning field trip stops at the Potsdam (PTN) and Lake Ozonia (LOZ) seismic stations.

Stop 2 Lake Ozonia (LOZ)

The seismic station was installed in 1983. Two stations are located at this site a short period vertical seismometer and a 3-component broadband seismometer. The short period vertical is powered by non-rechargeable aircell batteries which must be replaced on an annual basis. The broadband seismometer is powered by solar panels which keep the rechargeable batteries charged for a long period of time. The 3-component instrument gives a better S wave arrival time which gives better depth control on the hypocenter. The S-waves show up much better on the north and east components and are easier to read. The broadband instruments are also less likely to go off scale eliminating the clipping problem so the entire earthquake waveform can be recorded and analyzed.

Table 1 - List of principal facts about seismic field stations in the Seismic Network

Station Name	Station Code	Latitude Degrees	Longitude Degrees	Elevation Meters	Azimuth P-S	Azimuth S-P	Frequency MHZ	Audio HZ	Batteries	Seismometer	Distance Miles	Quadrangle	Land Owner
Potsdam	PTN	44.573	74.983	238	180	0	166.659	1700	Aircells	SP Vertical	8	Colton	John Colt
Massena	MSNY	44.998	74.862	55	0º	180	167.809	1360	None	"	22	Massena	NYPA
Bangor	BGR	44.829	74.374	326	80	250	416.806	1020	Solar Rechargeable	"	30	Bangor	Bruce Monette
Chipman	CHIP	44.798	75.195	97	300	130	406.281	2720	Solar Rechargeable	"	14	Waddington	John Fife
Lake Ozonia	LOZ	44.620	74.580	482	100	280	408.981	2040	Aircells	"	20	Lake Ozonia	Root Parker
Fine	FINE	44.265	75.157	354	300 F-BRC	120 BRC-F	408.506	1700	Aircells	"	28	Fine	Roger Fraser
Brasie Corners	BRC	44.428	75.583	126	240	65	408.506	2880	Solar and Aircell	"	34	Popes Mills	Raymond Hays
Mt. Arab	ARAB	44.212	74.590	776	150	330	461.075	1360	Aircell	"	40	Piercefield	State Land

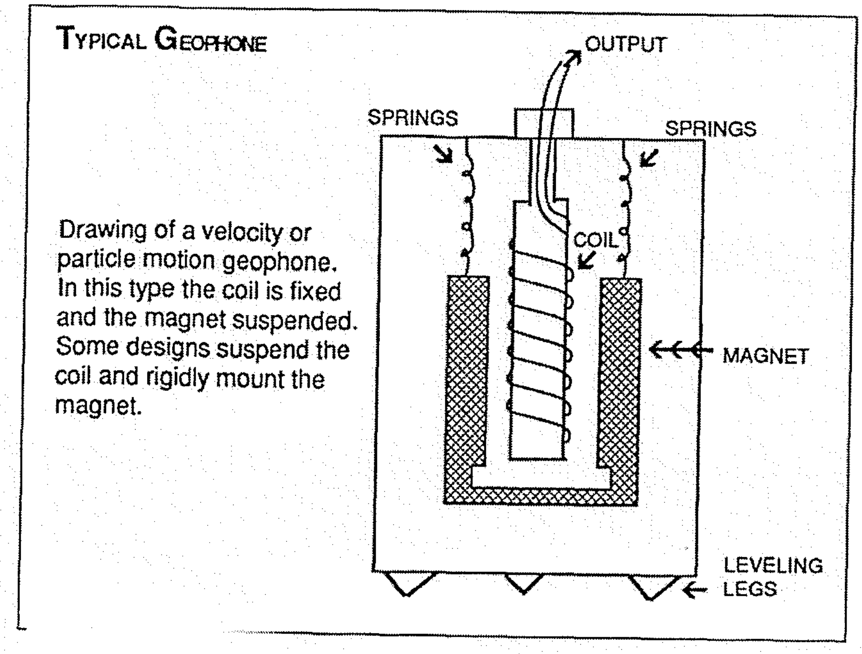

Figure 4 - Seismometer that detects earthquakes

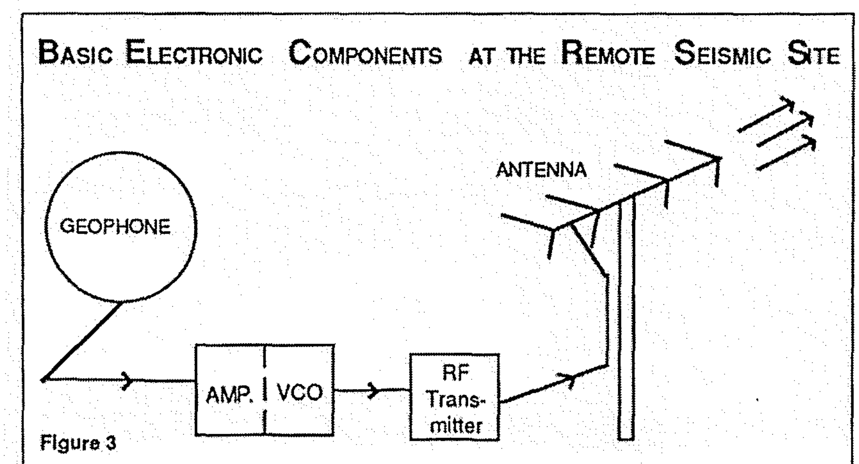

Figure 5 - Basic electronic components of a seismic field station

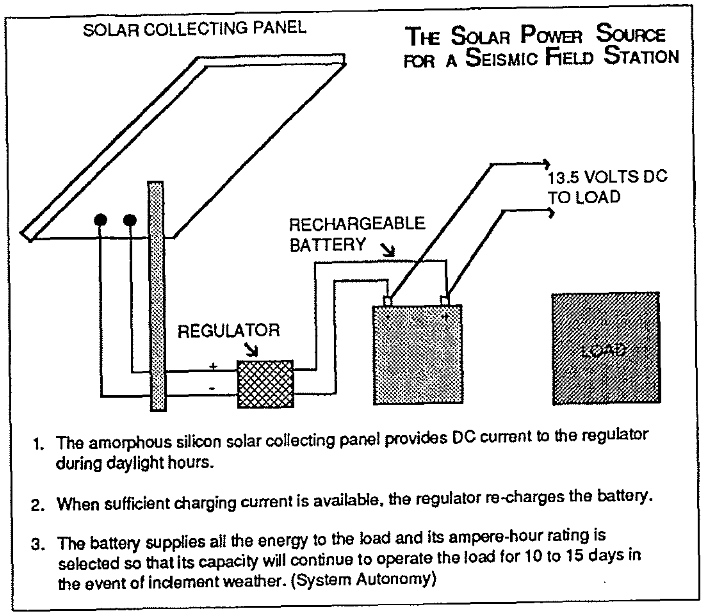

Figure 6 - Diagram showing basic components of a solar powered field station

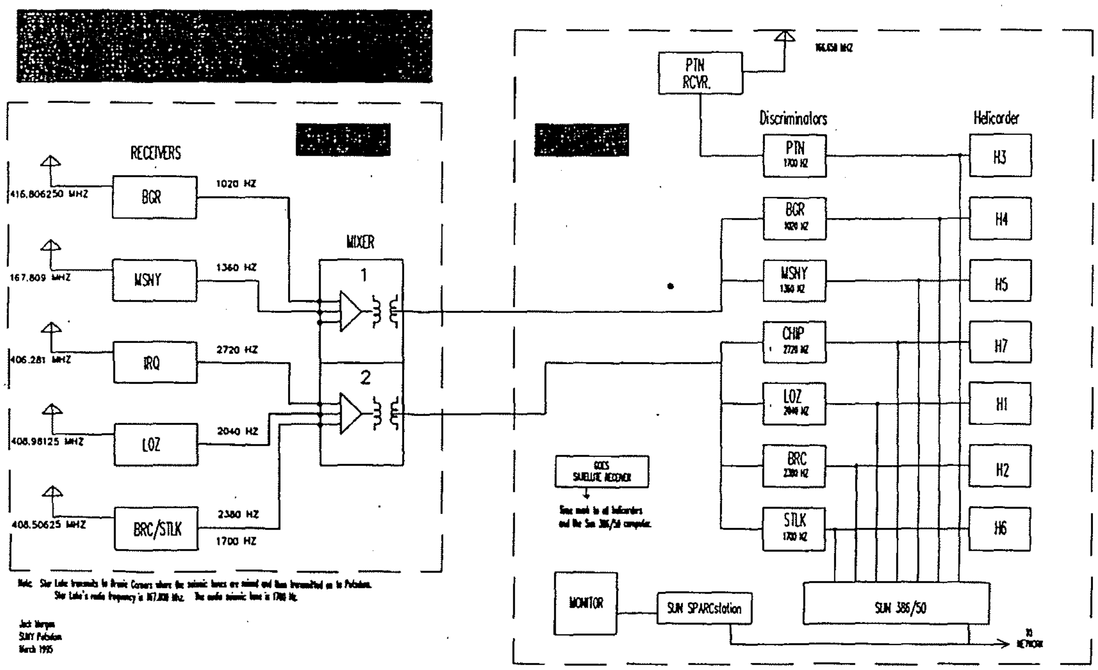

Figure 7 - Potsdam Seismic Network Components