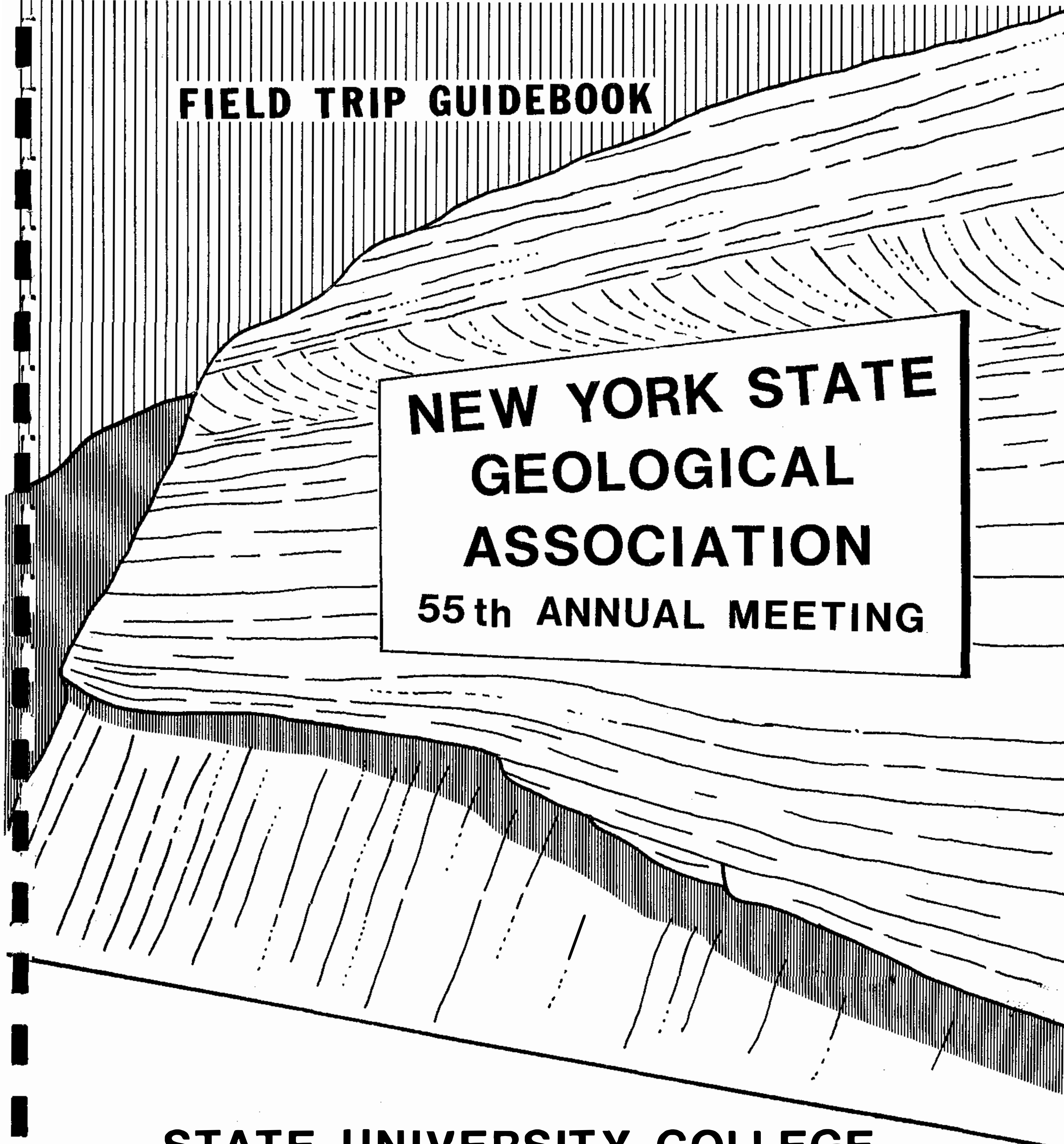

FIELD TRIP GUIDEBOOK

NEW YORK STATE GEOLOGICAL ASSOCIATION

55th ANNUAL MEETING

STATE UNIVERSITY COLLEGE of ARTS and SCIENCE POTSDAM, NEW YORK

SEPT. 23-25, 1983

FIELD TRIP NO. 1

SEISMOLOGY, TECTONICS AND ENGINEERING GEOLOGY IN THE ST. LAWRENCE VALLEY AND NORTHWEST ADIRONDACKS

by

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Introduction

The purpose of this field trip is to develop an understanding of the seismicity and tectonics of the St. Lawrence Valley in Northern New York and the engineering geologic aspects of the St. Lawrence Seaway and Power Authority of New York State. Six stops will be made - one in the vicinity of Norfolk, New York and five in the Massena area. The locations of all stops are shown on Figure 1.

Stop 1 will be near Norfolk, New York (Figure 1) to observe a seismic field station which detects earthquakes that are recorded at Potsdam State College. Stop 2 is at the St. Lawrence Seaway Development Corporation office in Massena, New York (Figure 1) where engineers will discuss the St. Lawrence Seaway System. Stop 3 will be at Massena Center, New York, the epicentral region of the Massena-Cornwall earthquake. At this stop residents who experienced this earthquake will share their recollections of the earthquake with you. Stop 4 will be at the Eisenhower Lock where the engineering aspects of the lock will be discussed. Lunch will be eaten here, and hopefully a ship may be observed passing through the lock. At Stop 5 we will view the Long Sault Dam and observe seismic equipment in operation to detect local earthquakes. Stop 6 will be at Moses-Saunders Power Dam where engineers will discuss the operations and construction of the dam. At this stop there are a number of exhibits and a 30-minute film on the construction of the St. Lawrence Power Project.

All participants will meet in Room 120, Timerman Hall at 8:00 A.M., September 24 to hear a slide-talk on the seismology, tectonics and engineering geology of the St. Lawrence Valley. Frank Revetta will speak on the Massena-Cornwall earthquake of September 5, 1944. Ellyn Schlesinger-Miller and Noel Barstow will discuss the seismology and tectonics of the Northern New York area. Bill Harrison will discuss the engineering geology of the St. Lawrence Seaway and Power Authority of the St. Lawrence River Valley. Slides will be shown of the stops made on the field trip. Participants will then proceed into the hallway for a brief discussion of the seismicity of Northern New York and the Lamont-Doherty Seismic Network.

FIELD TRIP SCHEDULE

8:00 - 9:00 A.M.	Room 120 Timerman Hall - Slide-talk on seismology, tectonics and engineering geology of St. Lawrence Valley
9:00 A.M.	Leave for field trip. Meet at parking lot behind Timerman Hall.
9:30 - 10:00 A.M.	Stop 1 Seismic Field Station near Norfolk, New York.
10:30 - 11:00 A.M.	Stop 2 St. Lawrence Seaway Development Building
11:30 - 12:00 A.M.	Stop 3 Massena Center: Epicenter of Massena-Cornwall Earthquake.
12:00 - 1:30 P.M.	Stop 4 Eisenhower Lock (Lunch)
1:30 - 2:30 P.M.	Stop 5 Long Sault Dam
2:30 - 4:00 P.M.	Stop 6 Moses-Saunders Power Dam
4:00 - 5:00 P.M.	Return to Potsdam

STOP 1 SEISMIC FIELD STATION

This stop will enable you to observe the operation of a seismic field station (Figure 2). The seismic equipment is contained in two 55 gallon steel drums. In one drum is a short period (1 second) horizontal geophone, preamplifier-voltage controlled oscillator, and an FM radio transmitter. The geophone is mounted on bedrock which, in this case, is the Ogdensburg dolomite. The geophone detects the ground motion and its voltage output drives the high-gain preamplifier. The amplifier drives a voltage controlled oscillator which is frequency modulated by the geophone signal. This seismic modulated tone is transmitted a distance of 10 miles via an FM transmitter and a high gain directional antenna to Timerman Hall at Potsdam State College. In the second drum are five McGraw Edison 1000 Ampere hour air cells which provide the power for the amplifier, VCO, and radio transmitter for one year.

At the receiver end is another high-gain directional antenna and an FM receiver. The signal, together with the FM carrier wave, is picked up by the receiver and passed into a discriminator where the carrier wave is removed. The signal then passes into the amplifier and into the heliocorder for recording.

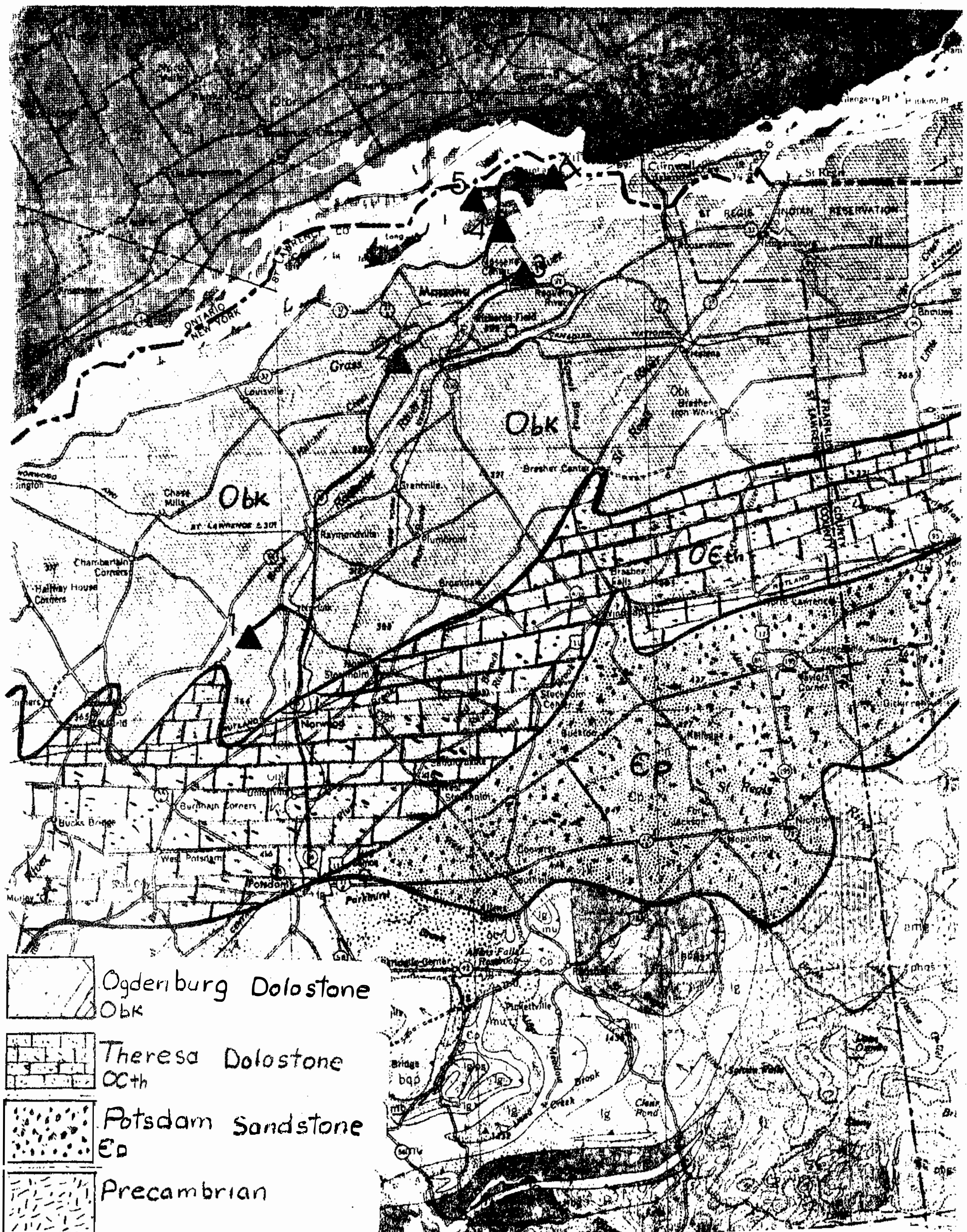

FIGURE 1 Map showing all stops and general geology

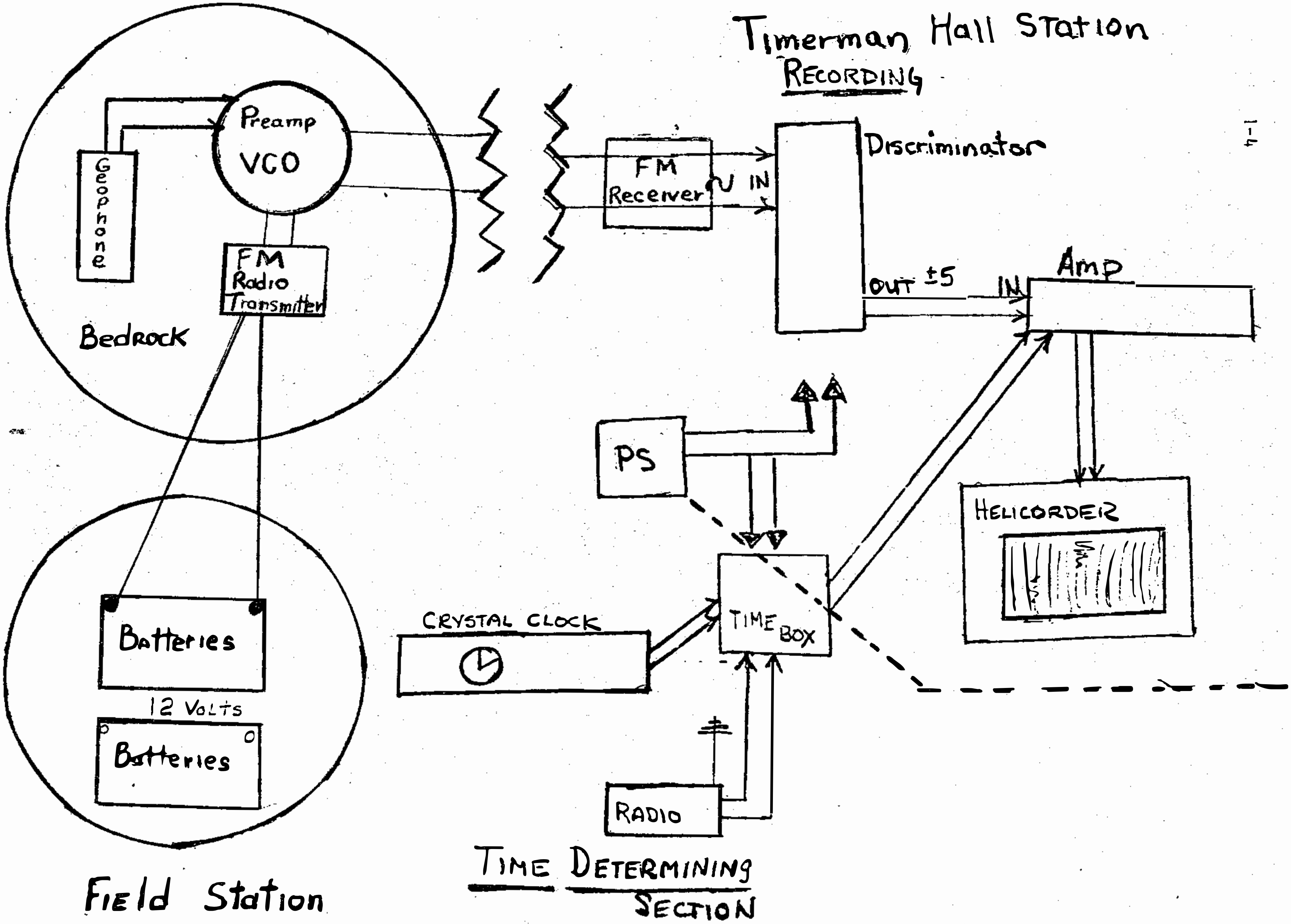

FIGURE 2 Seismic Field Station

STOP 2 ST. LAWRENCE SEAWAY DEVELOPMENT CORPORATION OPERATIONAL BUILDING

This stop is at the St. Lawrence Seaway Development Corporation's Administration Building at Massena, New York. At this stop engineers will discuss the construction and operation of the St. Lawrence Seaway. An explanation will be given of a wall display which depicts approximately 2300 miles of waterway from the headwaters of the Great Lakes to the Atlantic Ocean. You will also have the opportunity to view a model of the St. Lawrence Seaway and Power Projects, including the locks, Long Sault Dam, Massena Intake and Village of Massena.

STOP 3 MASSENA CENTER - EPICENTER OF THE MASSENA-CORNWALL EARTHQUAKE OF SEPTEMBER 5, 1944

Massena Center is the epicenter of the Massena-Cornwall earthquake of September 5, 1944 (Figure 3). The epicenter was located from P-phase arrival times and a least square solution and was found to be at 74^{o} 53.9 W longitude and 44^{o} 58.5' N latitude. The depth of focus of the earthquake was estimated to be 20 miles. The magnitude of the earthquake was 5.9 and a maximum intensity of VIII occurred in the vicinity of Massena Center. The total damage was estimated at $2,000,000.

An interesting fact regarding the damage was in the cemeteries. On the Canadian side of the river the tombstones were generally rotated counter-clockwise, and on the United States side they were generally rotated clockwise. It appears that this indicates horizontal displacement along a fault line parallel to the river even though geologists report no surface evidence of any major fault in the immediate area. However, the tombstones and chimney damage indicate an origin somewhere between Cornwall and Massena, which is confirmed from the study of seismograms. The cemeteries are the best evidence of the relative violence of the earthquake in different areas, and they furnish the chief line of division in determining the areas of major damage (Figure 3).

At this stop we will observe tombstones that have been rotated and translated by the Massena-Cornwall earthquake. Also, two Massena Center residents, Messrs. Bob Rickard and James Carton, who experienced the earthquake will discuss their recollections of the event.

STOP 4 EISENHOWER LOCK, ST. LAWRENCE SEAWAY

This structure enables ships traveling the St. Lawrence River to pass around the Moses-Saunders Power Dam and, along with Snell Lock five miles farther east, lowers the ships through a total of 95 feet of elevation. Both locks have dimensions of 850 feet by 80 feet and are of concrete construction. The locks are huge bathtubs, in a sense, with openings along the sides into a passageway (about 13' wide by 15' high) on each side which slopes to the upstream end of the lock. When a ship comes down the St. Lawrence River and through the canal to the lock, the lower lock gates are closed, and the water is at the upper canal elevation. The ship moves slowly into the "bathtub," the upstream gates are closed, and then the water is let out of the locks through the openings in their sides, down the passageway on either side and discharged below the lock. A system of baffles on the downstream end prevents excessive turbulence.

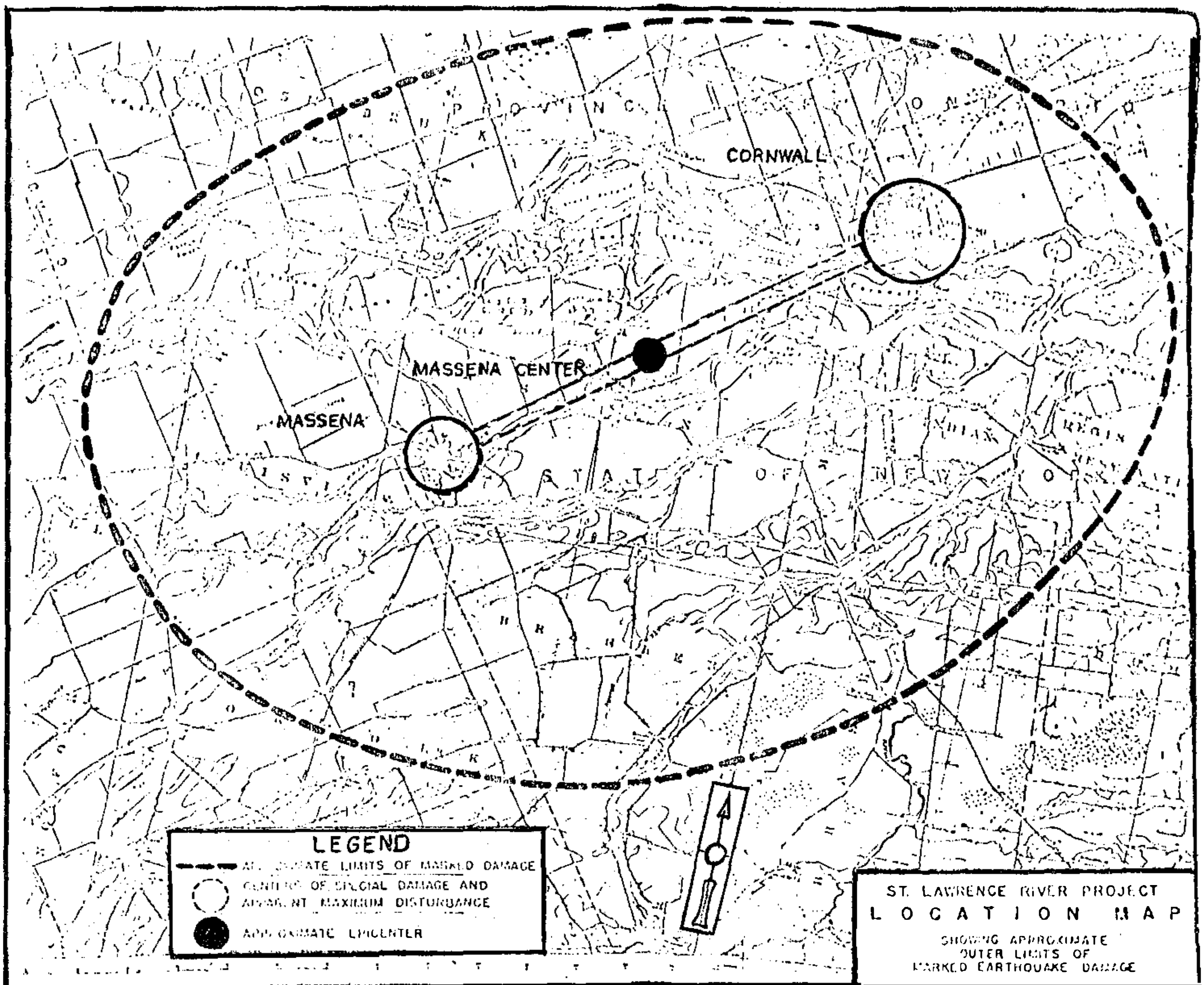

FIGURE 3 *Epicenter of the Massena-Cornwall earthquake*

When a ship comes upstream to the lock, the upper gates are closed and the water level is at the same elevation as the water surface downstream from the lock. The ship moves into the lock, the lower gates are closed, and water is introduced into the side passageways from the upstream end of the locks flowing into the lock through the side openings, thus filling the lock and raising the ship to the elevation of the canal on the upstream side. Then the upper gates are opened and the ship moves out of the lock upstream. Recently, some deterioration of the lock concrete has been observed, and an extensive study has been made by the Corps of Engineers, which is resulting in appropriate remedial measures.

At this stop we will visit the Eisenhower Lock Vessel Traffic Control Center to view its functions. Hopefully, we will see a ship pass through the lock. Lunch will be eaten at this stop and a concession stand is available.

STOP 5 LONG SAULT DAM

The Long Sault Dam is located just below the foot of Long Sault Island, crossing both the main channel of the St. Lawrence River and the smaller channel south of Long Sault Island. It is located four miles north of the Village of Massena, New York and 6.5 miles west of Cornwall, Ontario, Canada (Figure 4). The Long Sault dam serves as a control for the St. Lawrence River, developing approximately 82 feet of drop through the Long Sault Rapids. It is a concrete gravity structure having a maximum height of about 132 feet above foundation. The foundation of the dam is on bedrock (Ogdensburg Dolostone) and the dam is relatively noise free, therefore it is an ideal location for the installation of earthquake detection equipment.

This stop will enable you to observe some seismic equipment installed in the dam by the Lamont-Doherty Geological Observatory and the State University of New York at Binghamton. The dam is an ideal place for the installation of seismic equipment because it is coupled well to the bedrock of the area and is a quiet place. Three instruments may be observed on the lowest level of the dam: a short-period vertical seismometer, strong motion accelerograph (SMA) and a digital cassette accelerograph. The vertical seismometer and the strong motion accelerograph are part of the Lamont-Doherty Seismic Network and the digital event recorder is operated by SUNY at Binghamton.

The short period (1 second) vertical seismometer responds to the ground motion produced by an earthquake. The seismometer drives a high-gain amplifier. The amplifier drives a voltage controlled oscillator (VCO) which is frequency modulated by the seismometer signal. This frequency modulated audio tone is then inserted into a telephone line for transmission to Lamont-Doherty Geological Observatory. At the L.D.G.O. at Palisades, New York the various tones are distributed to the magnetic tape recorder and to appropriate discriminators. The discriminators separate the seismic data from the telephone line carriers. The data is transferred to develocorders and/or helicorders.

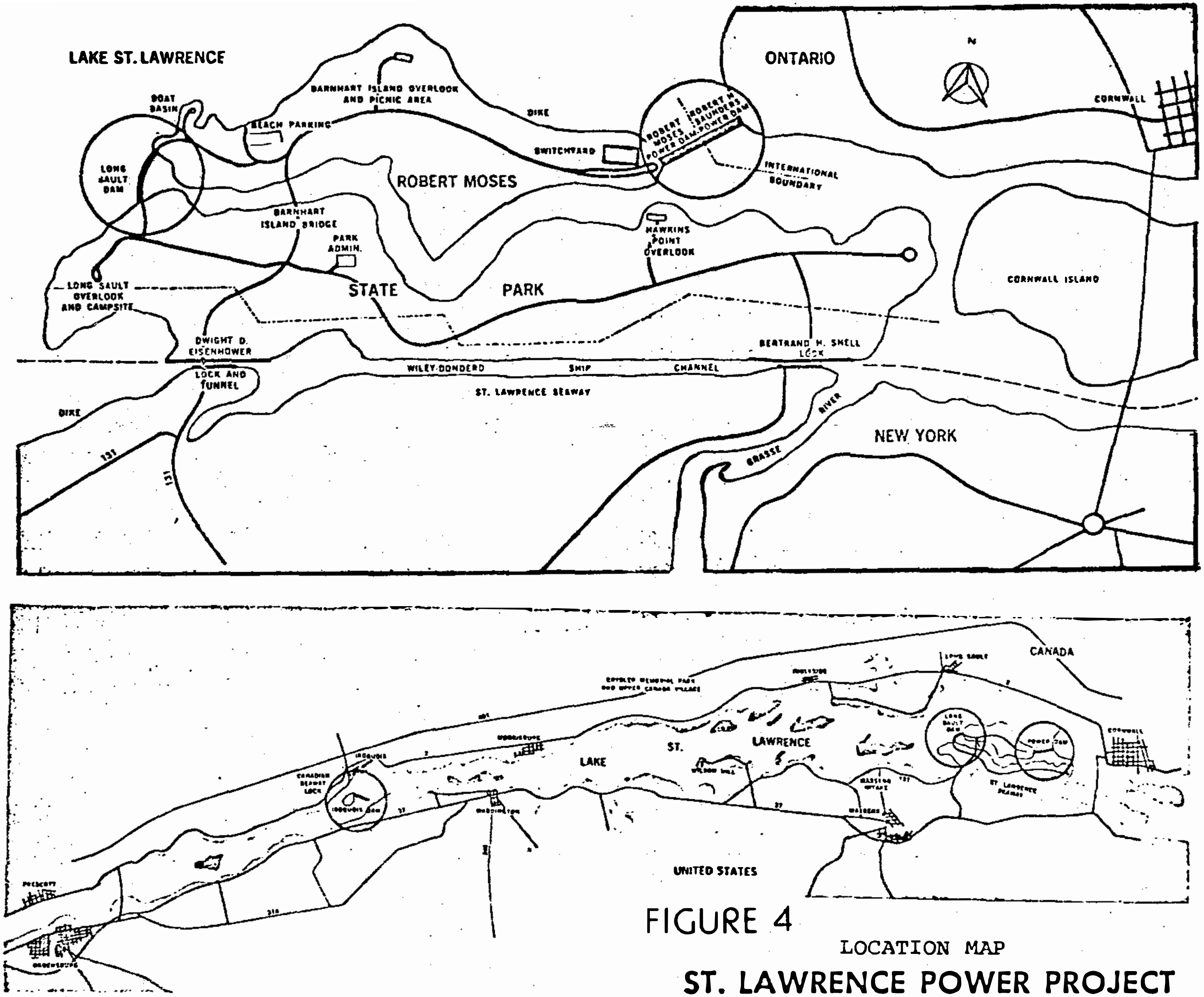

FIGURE 4

LOCATION MAP

ST. LAWRENCE POWER PROJECT

The strong motion accelerograph (SMA) was installed by the Lamont-Doherty Geological Observatory. This instrument contains three accelerometers that record on film the vertical and horitontal accelerations produced by a strong earthquake. The instrument remains in a standby condition until an earthquake triggers it. The "P" wave triggers the instrument which operates till the earthquake is recorded. The SMA can record a single earthquake or a sequence of earthquakes and aftershocks. The event indicator shows when an earthquake has been recorded. Before an event it is black, after the event, it is white.

The reason for recording such motions comes from two widely different scientific needs. Such measurements are necessary within man-made structures for engineers to develop structural design criteria in earthquake engineering. There is very little information about the accelerations produced by earthquakes in the eastern United States. Secondly, seismologists studying the details of the earthquake source for information on dimensions, stress drops and time histories of the rupture process need measurements in the near-field of larger earthquakes.

The third instrument is a digital cassette seismograph which belongs to Francis Wu, SUNY at Binghamton, New York. This instrument is triggered by the "P" wave and records the event on cassette tape. A portable playback-plotter accompanies the instrument to provide playback for set-up, testing, maintenance and analysis. The seismic data can be translated from cassettes to any IBM compatible tape and can provide a wide variety of seismological analysis.

STOP 6 MOSES-SAUNDERS POWER DAM; ST. LAWRENCE SEAWAY, MASSENA, NEW YORK

The location map is shown in Figure 4. This dam provides approximately 912,000 kilowatts of power. The dam has a head of 81 feet, and behind it is Lake St. Lawrence, with its fine marina and Barnhart Island Beach.

A thirty minute film will be shown in the auditorium at the dam, which will illustrate the methods and problems of construction.

A tour of the dam will be made, and from the top of the building Lake St. Lawrence can be clearly seen, with some of the zoned and rip-rapped dikes bounding it composed of compacted glacial till with dry densities on the order of 140 pcf (concrete is 150 pcf).

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