

PRELIMINARY REPORT OF LOCAL SEISMIC ACTIVITY AROUND SYOWA STATION, EAST ANTARCTICA

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Abstract: A local earthquake with 20 s *S-P* time was recorded at two seismic stations (Syowa and Tottuki) with three-component seismographs in Lützow-Holm Bay, Antarctica in June 1987. The earthquake was located at about 170 km northeast of Syowa Station. Its magnitude was estimated to be about 1.8. Other ten earthquakes of 20 s *S-P* time were recorded by a test small tripartite seismic array in East Ongul Island during March 1987.

The east Antarctic shield has been considered to be an aseismic area. It becomes clear, however, that some local earthquakes are located in the marginal area of the east Antarctic continent.

1. Introduction

A tripartite seismic array with three-component seismographs at each station was established in the northeastern part of Lützow-Holm Bay, East Antarctica in 1987. The seismic signals were transmitted by radio-telemetry to Syowa Station, Japanese Antarctic station at 69°S, 39°E. The main purposes of establishing the seismic network are to study the local seismic activity around Syowa Station and the propagation characteristics of seismic waves under the east Antarctic continent which is one of the most stable shield continents on the earth.

KAMINUMA (1976) reported that the seismicity around Syowa Station is less than one micro-earthquake per month. However, earthquakes occur in the marginal zone of the east Antarctic shield which is considered to be an aseismic area on the earth.

Some local earthquakes were recorded by the tripartite seismic array. The earthquake activities are reported briefly in this paper.

2. Seismic Observation Network

The seismic observation network consists of three sites with a three-component 1-s seismometer; Syowa Station in East Ongul Island (SYO), Tottuki Point (TOT) and Langhovde (LAN) as shown in Fig. 1. SYO is linked directly to the recording system in Earth Science Laboratory. TOT and LAN are located on the outcrops along the Prince Olav Coast and are linked by radio-telemetry to Earth Science Laboratory at Syowa Station. The distance between the sites ranges from 15 to 30 km. Three stations of E, W and S in East Ongul Island in Fig. 1 were used for a period from February to June in testing and calibrating the seismic observation system before

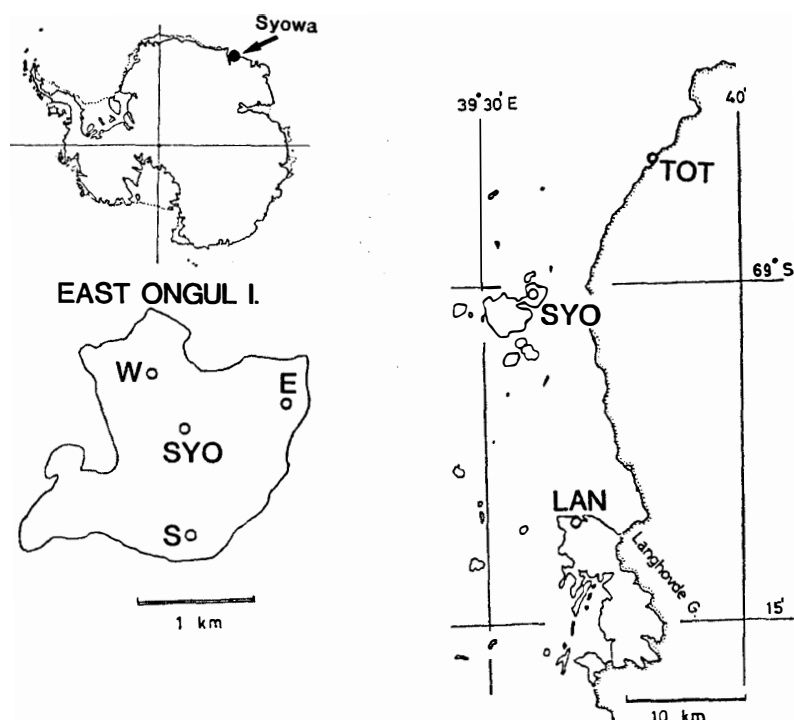


Fig. 1. Location of the tripartite seismic array. TOT and LAN are linked to Syowa Station (SYO) by radio-telemetry. Stations in East Ongul Island were used during the period from February to May 1987.

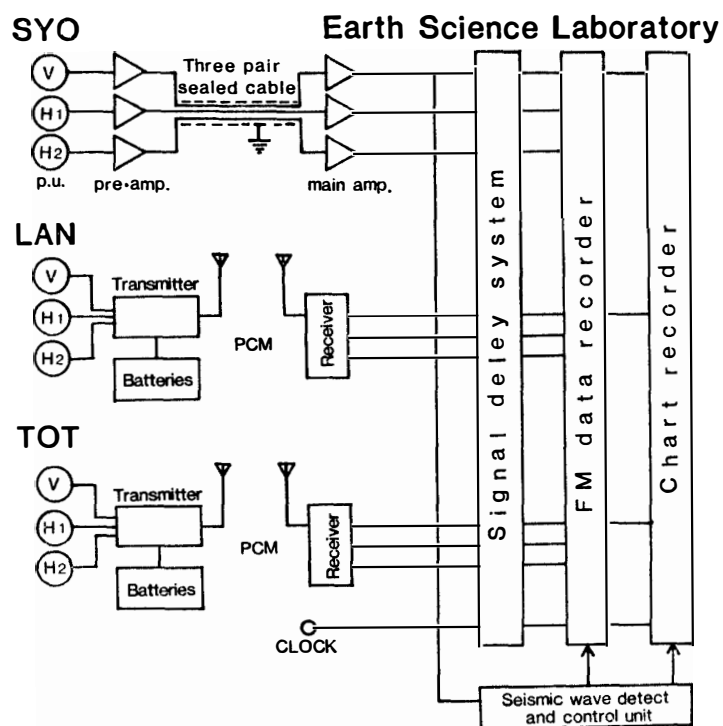


Fig. 2. Technical layout of the tripartite seismic network.

establishing the seismic array.

Earthquakes are detected by an event triggering method and the seismic signals are recorded on the FM magnetic tape with the monitoring chart. The transmitting and recording systems are shown in Fig. 2. The overall sensitivity of the network ranged from 0.56 to 1.25 mkine/V according to the noise condition, and it was fixed at 1.0mkine/V since August. The electric power at LAN and TOT was supplied by solar batteries. The observation at TOT was started in June 1987 and that at LAN was in August after the sea ice condition had become possible for the snow vehicle to traverse.

3. Seismic Activity

More than 3400 events were recorded by the seismic observation network during the period from June 1 to December 23. Most of the events seem to be icequakes and continuous vibrations caused by glacier movements. Figure 3 shows seismograms of an icequake which is estimated to be located near Langhovde from the difference of amplitude at the three stations. A glacier, a source area of icequakes, is located near the Langhovde. Icequakes were recorded mostly at only one station of the tripartite network. It is easy to detect icequakes empirically from their wave forms (KAMINUMA and HANEDA, 1979). About 270 events out of 3400 are earthquakes. Some of the earthquakes are teleseisms, although some ten local earthquakes were also included. Figure 4 shows typical vertical component seismograms of teleseisms which were recorded by the three stations of the tripartite seismic array at 0648, September 3, 1987.

On June 10, 1987, soon after the observation started at TOT, a clear local event was recorded at both SYO and TOT. The vertical component seismograms of the event recorded at SYO and TOT, and three component seismograms of SYO are given in Figs. 5 and 6 respectively. This event was recorded at 1936:50, June 10 and clear *P* and *S* phases are recognized on the seismograms in Figs. 5 and 6. The event was identified as an earthquake from its wave forms. The *S-P* time of the earthquake at SYO was 21.1 s, so the epicentral distance of the event is about 170 km. Estimating from the arrival time difference of the initial phases at SYO and TOT, and the initial phase directions of the three components at SYO, the earthquake was located at about

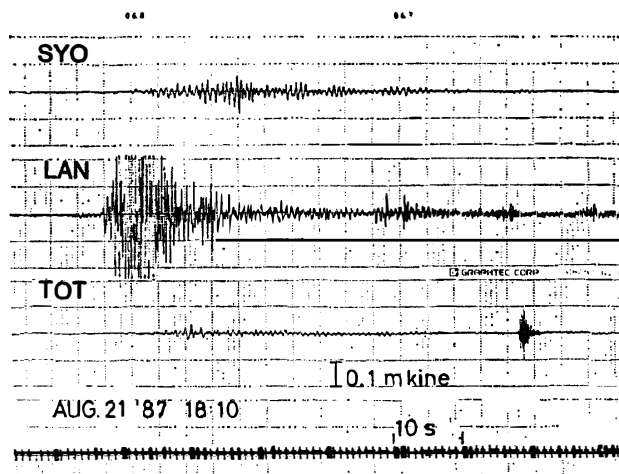


Fig. 3. Seismograms of an icequake which occurred near LAN.

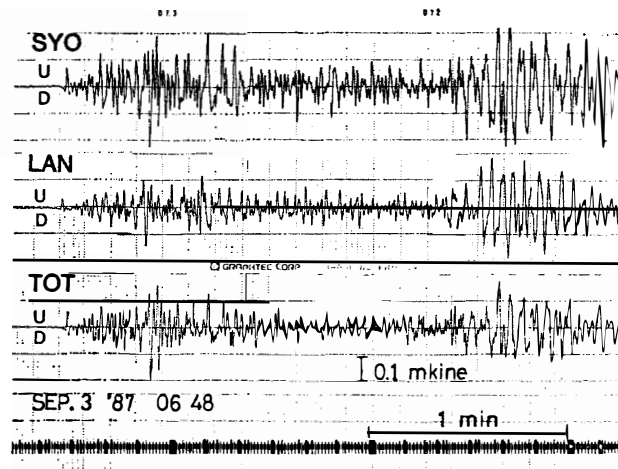


Fig. 4. Seismograms of a teleseism recorded at three stations of the tripartite network.

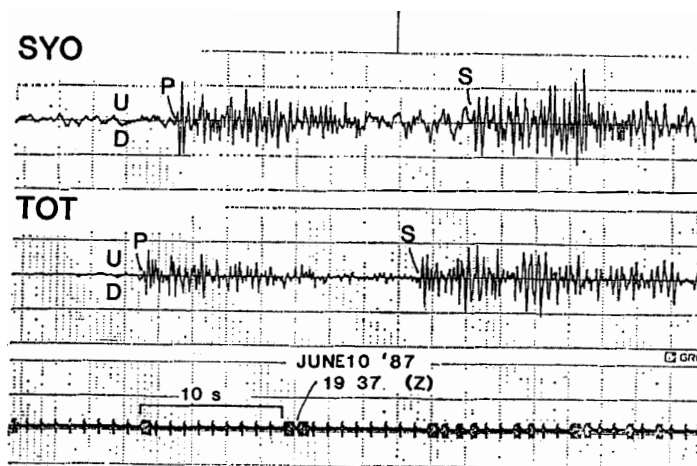


Fig. 5. Seismograms of the local earthquake located at 170 km northeast of Syowa Station.

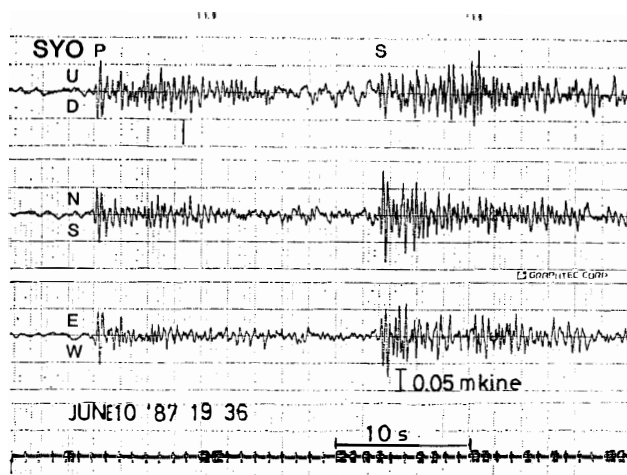
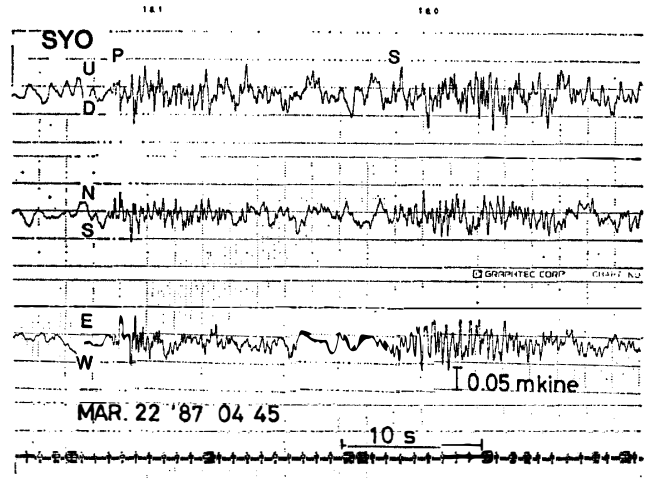


Fig. 6. Three component seismograms of the local earthquake recorded at Syowa Station.

Fig. 7. An example of seismograms of the local earthquake with 20 s S - P time recorded by the tripartite array in East Ongul Island.



170 km northeast of Syowa Station assuming a shallow source depth.

The magnitude of the earthquake was estimated to be 1.8 using Tsuboi's formula as follows:

Maximum amplitude of horizontal direction; $120 \mu\text{kine}$,
 predominant frequency; 3 Hz,
 maximum displacement amplitude; $A = 6.3 \times 10^{-2} \mu$,
 epicentral distance; $\Delta = 170 \text{ km}$,
 then $M = \log A + 1.73 \log \Delta - 0.83 = 1.8$.

The magnitude must be underestimated because there are no sedimentary layers around Syowa Station for amplifying the amplitude of seismic waves (ITO *et al.*, 1983; ITO and IKAMI, 1983).

Ten earthquakes with 20 s S - P time were recorded by the testing array network in East Ongul Island during four months from February to May. The wave forms of the ten earthquakes are similar to each other, and the typical seismogram of three components is shown in Fig. 7.

4. Discussion

The basement complex of the Prince Olav Coast region, named Lützow-Holm Complex, is known to have undergone a metamorphism different from the Rayner Complex around Molodezhnaya Station of U.S.S.R., 350 km northeast of Syowa Station. Although the boundary between the above two complexes is not clear, some geological faults seem to exist in the coastal area of the Antarctic continent, about 160–170 km northeast of Syowa Station. The local micro-earthquakes must be located around the faults.

It is very interesting that some local earthquakes are located around the geological faults which are inferred from the geological structure of the Prince Olav Coast and Enderby Land. The microseismic activity can be attributed to the occurrence of some microtectonic earthquake activity around Syowa Station (KAMINUMA, 1976). The temporary observation of the tripartite seismic array should be continued in order to obtain more seismic data of local earthquakes.

Acknowledgments

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