UNITED NATIONS

GENERAL ASSEMBLY

Distr.
GENERAL

A/7967/Add.2
19 May 1970
ENGLISH
ORIGINAL: ENGLISH/FRENCH/
SPANISH

Twenty-fifth session

URGENT NEED FOR SUSPENSION OF NUCLEAR AND THERMONUCLEAR TESTS

Information relating to the creation of a world-wide exchange of seismological data

Note by the Secretary-General

Addendum

For the period from 22 April to 1 May 1970, the Secretary-General had received, in response to his letter dated 30 January, communications from seventeen States, the substantive portions of which are reproduced below.

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BELGIUM

[Original: French]
30 April 1970

"... Attached to this letter is the reply prepared by the Belgian Government in response to your request.

...

1. Name of station:

Earth Physics Centre (Centre de Physique du Globe), Dourbes

Operating organization:

Royal Meteorological Institute of Belgium (Institut Royal Météorologique de Belgique)

2. Co-ordinates: Latitude 50° 06' N
Longitude 4° 36' E
Elevation 208 metres

3. Instrumentation:

(a) Long-period instruments:

1 Sprengnether vertical seismometer

2 Sprengnether horizontal seismometers

Speed of recording: 60 mm/minute

(b) Short-period instruments:

1 Benioff vertical seismometer

2 Benioff horizontal seismometers

Speed of recording: 60 mm/minute

Operational magnification: 300,000

Response curves not available.

4. Geological description:

The commune of Dourbes and the massif on which the Earth Physics Centre is situated are shown on sheet 192 ("Olloy-Treignes") of the geological map of Belgium at 1:40,000.

Most of the region consists of Devonian system rocks. Dourbes and its environs immediately to the east and west, i.e., on Upper Devonian (Lower Frasnian) formations.

/...

The massif on which the Centre stands is principally composed of red and grey marble surrounded by various schists often nodulous at the base. The geological map refers to detrital material at the summit of the massif (level 235). To the south-west and north-east there are massive or nodulous stratified limestones. Middle Devonian (Givetian stage) formations appear in the north-west in the form of a massif extending along the general direction of folding, i.e., WSW-ENE.

These Givetian formations are based on Givet limestone of Stringocephalus burtini (Gva), which forms the core of the Dourbes-Fagnolle anticlinal region. The longitudinal extension at outcropping of this core of Gva is of the order of four kilometres and its maximum breadth is about one kilometre. In the north-east section the Givetian massif is extensively overlain by an outlier formation of the Upper Landenian (Lower Eocene). This tertiary pocket is made up of fine clayey sand with sandstone boulders.

Within the massif of Givetian rock there are a number of small seams trending NNW-SSE with mineralization in pyrite and galena, occasionally with copper and barytes. Some of these seams were once mined, but these activities have now been abandoned.

5. 35 mm.

6. Yes."

BULGARIA

[Original: French]
25 April 1970

"During the discussion of the question of concluding a treaty banning underground nuclear weapon tests the Bulgarian representatives in the Committee on Disarmament and the General Assembly clearly stated the position of the Bulgarian Government, namely, that national detection means would permit effective verification of the implementation of such a treaty. Advances in contemporary science and technology in the sphere of seismology now enable underground tremors to be detected and identified effectively and enable natural earthquakes to be distinguished from nuclear explosions.

Data registered by national seismic stations constitute a reliable guarantee of compliance in good faith with the ban on underground nuclear weapon tests and accordingly it is neither necessary nor advisable to institute international control.

The People's Republic of Bulgaria is participating, in so far as its resources permit, in the international exchange of seismological data, but it considers that the exchange of data relating to seismic stations is unnecessary and unjustified.

The Government of Bulgaria takes this opportunity to confirm that it is prepared to take an active part in the negotiations on the preparation of a treaty banning underground nuclear weapon tests."

COSTA RICA

[Original: Spanish]
29 April 1970

"The following information is offered although, owing to budgetary limitations, none of the stations referred to below is currently in operation.

San Pedro de Poás station (SPP)

10° 04' 39.2" N 84° 15' 04.2" W
Elevation 1,120 metres
Foundation: deep volcanic ash moderately weathered

La Lucha station (LL)

09° 44' 18.9" N 83° 59' 31.6" W
Elevation 1,400 metres
Foundation: weathered sedimentary rock

Sanatorio Durán station (SD)

09° 56' 10.4" N 83° 53' 07.6" W
Elevation 2,340 metres
Foundation: very deep volcanic ash, old and recent

All three stations are operated by the Seismology and Volcanology Section, Directorate of Geology, Mines and Petroleum, Ministry of Industry and Commerce.

The three stations have the same instrumentation, which is as follows:

1 Electrotech EV-17 vertical seismometer, T_o = 1.0 second

2 Electrotech EV-17H horizontal seismometers, T_o = 1.0 second

3 Geotech Mod. 4100-301 m galvanometers, T_o = 287 to 283

1 Sprengnether TS-100 crystal-controlled chronometer

1 Recording drum for three Lehner and Griffith components Mod. DR 273 (3)

Recording is photographic, speed 1 mm/second

1 radio for WWV time signals

1 radio for NBA time signals

Electric-pulse radio signal converter

Magnification is as follows:

SD	Z:	33,750, 22,500, 16,875 and 11,250
	E:	22,500, 16,875, 11,250 and 8,437.5
	N:	22,500, 16,875, 11,250 and 8,437.5
LL	Z:	67,500, 45,000, 33,750 and 22,500
	E:	33,750, 22,500, 16,875 and 11,250
	N:	33,750, 22,500, 16,875 and 11,250
SPP	Z:	11,250, 8,437.5, 5,625 and 4,218.25
	E:	5,625, 4,218.75, 2,812.5 and 2,109.38
	N:	5,625, 4,218.75, 2,812.5 and 2,109.38

"Since the seismic stations are not in operation, it would be impossible to offer a record exchange or delivery service at this time, for the reasons stated. It is hoped, however, that the difficulties will be overcome and that it will be possible in future for the requested co-operation to be extended."

CZECHOSLOVAKIA

[Original: English]
23 April 1970

"The Czechoslovak Socialist Republic considers an agreement for the prohibition of underground nuclear tests as an important step in the field of nuclear disarmament and, therefore, it has already for years consistently striven for its conclusion in the Geneva Disarmament Committee. It has once and again emphasized that the solution of that question depends primarily upon a political decision and that the prohibition should be verified exclusively on the basis of the use of national means of detection.

This opinion is based on the fact that the present stage of seismographic science offers sufficient guarantees that the agreement be duly implemented. The Czechoslovak Government is of the opinion that the efforts aimed at creating an international verification system for the needs arising from the agreement are unwarranted and in this connexion does not, therefore, see any necessity of the proposed exchange of information on seismic stations.

As far as the international exchange of seismic data themselves is concerned, Czechoslovakia has taken an active part in the co-operation in this field for more than half a century."

DENMARK

[Original: English]
22 April 1970

"[Attached is the information requested by resolution 2604 A (XXIV)]

"A. Conventional Seismograph Stations

(i) Conventional seismograph stations exist in the following locations:

Copenhagen
Godhavn (Greenland)
Kap Tobin (")
Nord (")

/...

The operating organization is the Geodetic Institute. Correspondence concerning the stations should be addressed to:

Geodetic Institute
Department of Seismology
Vodroffsvej 4
DK 1900 Copenhagen

(ii) and (iii) Data on co-ordinates, elevations and instrumental constants will be seen from the table included as annex 1. Response curves are shown in annexes 2, 3, 4, and 5.

The table in annex 1 includes data on the geological foundation. Time recordings by means of WWSS are controlled by quartz clocks adjusted daily to a time correction of less than 5 milliseconds. Recordings are made twenty-four hours a day except for an interval of about five minutes for change of registrations.

There are no technical obstacles to prevent copies of all registrations from being made available. With existing installations, copies can be made on 70 mm film on a 1:8 scale. With the technique used at the Greenland stations, notably Station Nord, the time interval between a registration and the date when copies are received in Copenhagen may be up to two months.

Every day, six registrations are recorded at each of the four WWSS stations, i.e. 8,760 registrations per year. An international exchange covering all registrations would require an increase of the present financial allocation. If an international exchange of data is established, the Danish Government is prepared to apply for parliamentary appropriation of the funds required for Danish participation.

In that event, Denmark will be prepared to deposit copies of all records in a seismological centre which makes its data available to everyone.

Efforts are being made to expand and improve the seismic service and, in particular, to place certain newly developed long-period ultrasensitive seismographs on Greenland.

B. Array Stations

No array stations are in operation in Denmark."

Annex 1

Table 1
Present seismological observatories

Station	Seismograph	Seismometer period sec.	Galvanometer period sec.	Magnification at seism. per.	Recording speed mm./min.	In operation since	Remarks
Kobenhavn: ..... (Vault 13)	Wiechert Z	6		200	10	March 1927	Mechanical seismograph. Damping about 4:1
55°41′ N, 12°26′ E	Wiechert N and E	8.5		200	12		Mechanical seismograph. Damping about 6:1
13 m. Chalk.	Benioff Z	1.0	0.25	12 ×10³	60	December 1936	
	Galitzin-Wilip Z	12.5	12.5	820	30	March 1927	
	– N	12.5	12.5	820	30		
	– E	12.5	12.5	820	30		
(Vault 14)	WWSS SPZ	1.0	0.75	12.5×10³	60	February 1962	(Vault 14 is situated 670 m
55°41′ N, 12°26′ E	SPN	1.0	0.75	12.5×10³	60		north of vault 13).
13 m. Chalk.	SPE	1.0	0.75	12.5×10³	60		
	LPZ	15	100	750	15		
	LPN	15	100	750	15		
	LPE	15	100	750	15		
Godhavn:	WWSS SPZ	1.0	0.75	25×10³	60	November 1962	No operation 1912-1962.
69°15′ N, 53°32′ W	SPN	1.0	0.75	25×10³	60		
23 m. Gneiss.	SPE	1.0	0.75	25×10³	60		
	LPZ	15	100	1500	15		
	LPN	15	100	1500	15		
	LPE	15	100	1500	15		
Kap Tobin:	WWSS SPZ	1.0	0.75	12.5×10³	60	July 1963	This station continues the
70°25′ N, 21°59′ W	SPN	1.0	0.75	12.5×10³	60		operation of Scoresby-
6 m. Gneiss.	SPE	1.0	0.75	12.5×10³	60		sund which was situa-
	LPZ	15	100	550	15		ted 8.5 km far north.
	LPN	15	100	750	15		
	LPE	15	100	750	15		
Nord:	WWSS SPZ	1.0	0.75	5×10³	60	November 1963	These instruments continue
81°36′ N, 16°41′ W	SPN	1.0	0.75	5×10³	60		the work begun September
36 m. Calcareous	SPE	1.0	0.75	5×10³	60		1957 during the I.G.Y.
greywacke.	LPZ	15	100	750	15		
	LPN	15	100	750	15		
	LPE	15	100	750	15		

[Annexes 2-5 to the above communication, containing additional information on Denmark's seismic stations, namely - response curves for the stations - are deposited in the archives of the United Nations and interested delegations may consult them upon request to the Disarmament Affairs Division.]

FEDERAL REPUBLIC OF GERMANY

[Original: English/German]
29 April 1970

"The Government of the Federal Republic of Germany is taking an active part in the disarmament and armaments control efforts. Accordingly, it supports any endeavour for a complete ban of nuclear weapons, and it is prepared to participate in the planned international exchange of seismological data.

... enclosed [is the] information on the Central Observatory of the Federal Republic of Germany at Fraefenberg. This Observatory - owing to its technical equipment - will be in the position continually to furnish an international centre with all seismological data recorded in the Federal Republic of Germany.

With this act of international co-operation, the Government of the Federal Republic of Germany hopes to contribute to progress towards a comprehensive ban of all nuclear weapons tests.

A seismological central observatory with a small array is in operation in the Federal Republic of Germany. It will be enlarged to an array station of medium size. The Government of the Federal Republic of Germany participates directly through its geological survey in this institution. The central observatory (Graefenberg) has close contact with the conventional or special stations at universities in our country.

The station is situated in an area carefully selected by measurements of the natural seismic background noise in many parts of the Federal Republic. Average noise-level is 2-3 millimicrons. The cristalline basement there is covered only by some 100 metres of sedimentary layers, predominantly limestone, dolomite and sandstone. The station seems to have a good signal to noise ratio and to give good signals. The further extension of the array to a long L will stay in the same geological formation and therefore promises homogeneous data.

The geological survey (gs) of the Federal Republic in Hannover-Buchholz, POB 54, phone 0511-64681, Telex 9 23730, gives the following data for the central seismological observatory Graefenberg. Copies of recordings (see below) will be made available within a few days depending on postal and personnel conditions. On request, data could be transmitted by telex.

/...

Instrumentation

Crossed array with short-period vertical Benioff-seismometers (ts = 1s) and one short-period 3-component set Benioffs in the array crosspoint and a long-period Sprengnether-seismometer 3-component set (ts = 20 s). The seismometer signals are routed through a bridged-t attenuator to galvano meters of phototube amplifiers which provide the signals for the diverse recording equipment.

Recording

1. Optical

On 16-mm film all short-period channels (one roll of 50 m per day),

on 35-mm film separate the channels of the short-period and long-period 3-component sets (for each seismometer one film of 90 cm per day).

2. On thermosensitive paper

With helicorder (geotech model 2484) two channels (in general sz3 and 1z) for monitoring (one sheet of 30 x 90 cm per day).

3. On magnetic tape

5-inch tape, 7 channels frequency modulated according to irig standard, the short- and long-period 3-component systems (one 10,5 inch roll with approximately 1,000 m of tape within five days, r = 4 143 mm'min = 15'160 ips amplification:

short period m = 50 000 at 1 hz

long period m = 15 000 at 1'20 hz

(base d on optical view with magnification of 10)

geological conditions: Limestone and dolomite (jurassic)

accuracy of time marks: better than 50 milliseconds

copies of records: continuous copies of 16-mm and 35-mm films are possible and playback of magnetic-tape records. Installations for copies of magnetic-tapes are planned.

Co-ordinates and hights of array-points:

Right-angle cross - array:

One branch 320 degrees n, other branch 50 degrees n.

Branch length 3 km. Distance of sensors 1 km.

/...

Co-ordinates of crossing point z3:

Lamda = 11 degree, 12'55''e

phy = 49 degree 41'32''n

hight = 525m.

Hights of sensors direction 320 degree:

Z4 - 555 m, z3 = 525 m, z2 = 550 m, z1 - 510 m

direction 50 degree.

Z7 = 510 m, z3 = 525 m, z6 = 500 m, z5 = 480 m.

For direct contacts with the central station address:

Seismologisches Observatorium,

852 Erlangen

Naegelsbachstr. 54

Phone: Bureau Erlangen 09131-328

Recording station: Haidhof (Graefenberg) 09197-329

Telex: 0629706 grf d

International code word: grf.''

FINLAND

/Original: English/
27 April 1970

"... herewith /is/ the reply of the Government of Finland together with the national report on seismology and physics of the earth's interior 1967-1969.

A. Conventional seismograph stations

(i) Name of stations	Name and address of the operating organization
NUR (Nurmijärvi), KEV (Kevo), KJN (Kajaani), JOE (Joensuu), HEL (Helsinki)	Institute of Seismology University of Helsinki Et. Hesperiankatu 4 Helsinki 10, Finland

Name of stations	Name and address of the operating organization
SOD (Sodankylä)	Geophysical Observatory Finnish Academy of Sciences Tähtelä, Sodankylä Finland
OUL (Oulu)	Department of Geophysics University of Oulu Pikkukangas, Oulu Finland

The international data service through the Institute of Seismology, University of Helsinki, Helsinki

(ii) See table 1, page 8, National Report, Seismology and Physics of the Earth's Interior, 1967-1969 (enclosed).

(iii) See table 1, page 8, National Report (enclosed).

Geological description of the station foundation:

Station	Elev. m.	Bedrock
KEV	97	granulit
SOD	181	30 m sand on mica schist
OUL	60	mica schist
KJN	250	gneiss
JOE	90	mica schist
NUR	102	gneiss
HEL A (NUR	102	gneiss
HEL A (PRV	25	mica gneiss
HEL A (PKK	10	gneiss

Fully annotated records are available.

Good quality film negative copies could be provided in a size of 1:10; NUR and HEL within 1-2 days and the other within one week. All data, and occasionally also records, could be delivered to the international centre and are also available to everyone.

/...

B. Array stations

(i) HEL (Helsinki) - Institute of Seismology
University of Helsinki
Et. Hesperiankatu 4
Helsinki 10, Finland

(ii) NUR - N 60° 30' 32.4"; E 24° 39' 05.1"
PKK - N 60° 00' 18.7"; E 24° 31' 01.0"
PRV - N 66° 21' 25.7"; E 25° 33' 30.1"
HEL - N 59° 14' 11.7"; E 24° 55' 12.7"
(under installation)

For elevations see table "Geological description of the station foundation".

(iii) See report "Tripartite array of Helsinki", page 9, National Report (enclosed)

(iv) See table 1, page 8, and report "Tripartite array of Helsinki", page 9, National Report (enclosed)

Magnification 24,000/1 sec at present.

(v) NUR, PRV, PKK

TRIPARTITE ARRAY OF HELSINKI

S.E. Pirhonen

After many phases of development taking a number of years in the Institute of Seismology satisfactory stability has been achieved in the operation of the tripartite station of Helsinki (NURMINEN, [2]). A vertical short-period seismometer has been installed at each of the three stations, which are at Nurmijarvi (NUR). Porvoo (PRV) and Porkkala (PKK). The distances between the stations are 52.5, 69.8 and 56.6 km respectively.

The outputs of the Willmore Mk I seismometers are transmitted by a F.M. system, using ordinary telephone lines, to Helsinki, where the signals are recorded on magnetic tape with an Ampex FR 100C recorder and also on heat-sensitive paper for visual detection. The paper recording speed is 1 mm/sec. The magnetic tape is 1/2 inch wide, and recordings are made on three signal channels and one time channel. At a tape speed of 15/16 inch/sec, 14-inch diameter reels have a recording duration of one day.

/...

Using analogous filters and visual transcription from the magnetic tape with a paper speed of 15 mm/sec the reading accuracy of the P-waves is about ± 0.04 sec. NOPONEN [1] has made the computer programmes for location of near and teleseismic events. Location of nearby events is based on local travel time curves for P and S waves and the accuracy is better than 5 per cent of the distance. Teleseismic events are located on the basis of the determination of the azimuth and the apparent velocity of the approaching wave front from the onset of the P waves. The accuracy is satisfactory for middle distance earthquakes. A more detailed analysis of the Helsinki tripartite arrays is in progress.

Table 1. The instrumentation of the station network

Station	Component	Type of instrument	Free period sec. Ts	Free period sec. Tg	Magnification at Ts.	System damping ratio	Recording type	Drum speed mm/min	Geographical coordinates	Type of amplifier	Remarks
KEV	Z	Press-Ewing	15	100	1 500	∞	Photo paper	1) 30	2) 69°45'21.2"N	Galvanomet.	1) 15 since May 01, 1967
	N	»	15	100	1 500	∞	»	1) 30	27°00'45.1"E	»	2) Since Jun 01, 1967 69°45'19"N 27°00'24"E h = ca. 80 m
	E	»	15	100	1 500	∞	»	1) 30	h = 97.2 m	»	3) Since Oct. 28, 1967 200 000
	Z	Benioff	1	0.75	25 000	17:1	»	60		»	4) 15 since May 01, 1967
	N	»	1	0.75	25 000	17:1	»	60		»	5) 37 000 since Sept. 09, 1967
	E	»	1	0.75	25 000	17:1	»	60		»	
SOD	Z	Benioff	1	0.2	20 000	5:1	Photo paper	60	67°22'16.2"N	Galvanomet.	
	Z	Willmore	1	0.2	47 000	6:1	Heat sensitive		26°37'44.7"E	Phototube	
									h = 181 m		
OUL	Z	Press-Ewing	15	100	1 500	∞	Photo paper	30	65°05'07"N	Galvanomet.	
	Z	Willmore	0.65	0.2	3) 360 000	4:1	Heat sensitive	60	25°53'47"E	Phototube	
KJN	Z	Benioff-Portable	1	0.75	46 000	17:1	Photo paper	60	64.1°N	Galvanomet.	
	N	»	1	0.75	46 000	17:1	»	60	27.7°E	»	
	E	»	1	0.75	46 000	17:1	»	60	h = 250 m	»	
JOE	Z	Willmore	1	0.2	33 000	4:1	Heat sensitive	60	62°39.1'N 29°41.7'E h = 90 m	Phototube	
NUR	Z	Press-Ewing	15	100	1 500	∞	Photo paper	4) 30		Galvanomet.	
	N	»	15	100	1 500	∞	»	4) 30	60°30'32.4"N	»	
	E	»	15	100	1 500	∞	»	4) 30	24°39'05.1"E	»	
	Z	Benioff	1	0.75	25 000	17:1	»	60	h = 102 m	»	
	N	»	1	0.75	25 000	17:1	»	60		»	
	E	»	1	0.75	25 000	17:1	»	60		»	
	Z	Nurmia	0.6	0.2	5) 230 000	3:1	»	60		»	
	Mickro-Bar.	Yanagi	—	—	—	—	Ink record	3		Mechanical	
HEL	Z	Willmore	1	—	18 000	3:1	Heat sensitive	60		Electricial	△-station

[There is attached to the above communication: National Report, Seismology and Physics of the Earth's Interior, 1967-1969, which, among other things, contains Magnification curves (Fig. 1, p.7). This report is deposited in the archives of the United Nations and interested delegations may consult it upon request to the Disarmament Affairs Division].

IRELAND

/Original: English/
1 May 1970

"... attached /is the/ information relating to the Valentia Observatory, which is the only seismograph station in Ireland:

Name of Station	Valentia Observatory
Operating Organization	Irish Meteorological Service
Co-ordinates	Lat. 51° 56' N Long. 10° 15' W
Elevation	13.7 metres
Instrumentation	WWSSN System Short Period - 3 Benioff seismometers for component recording i.e. N - S, E - W and Vertical. Magnification 12,500; Recorder Speed 60 mm./min. Long Period - 3 Sprengnether seismometers for 3 component recording (N - S, E - W and Vertical). Magnification 750; Recorder Speed 15 mm./min. Magnification of Short and Long period seismometers may be increased at times to 25,000 and 1,500 respectively when weather conditions are suitable. A copy of the response curves is attached.
Time precision	± 10 ms.
Foundation	The station rests on slate deposits from the recently uplifted shoreline of the ocean.

Fully annotated records can be provided. These would be in the form of full size contact photographic copies.

Original records are, according to existing routine, sent fortnightly to the Seismological Department of the U.S. Coast and Geodetic Survey for micro-filming after which the original records are returned to Valentia.

/...

Data from the records are punched on cards, copies of which are forwarded to the International Seismological Centre in Edinburgh, Scotland, for inclusion in the International Seismological Bulletin and Catalogue of Earthquakes which are available to everyone.

[Annex to the above communication containing frequency response of the World-Wide Standard Seismograph is deposited in the archives of the United Nations and interested delegations may consult it upon request to the Disarmament Affairs Division.]

JAPAN

[Original: English]
23 April 1970

"... [enclosed] herewith [is] a document entitled 'List of Seismological Stations in Japan' and annexes attached thereto as the information referred to in the annex to resolution 2604 A (XXIV) of the United Nations General Assembly:

LIST OF SEISMOLOGICAL STATIONS IN JAPAN

A. Conventional Seismograph Stations

1. Matsushiro Seismological Observatory of the Japan Meteorological Agency

Saijo 3511, Matsushiro-machi. Nagano-shi, Nagano-ken, JAPAN

Latitude: 36° 32' 30" N; Longitude: 138° 12' 32" E; Elevation 440 m (station), 425 m (seismometers); Geological Foundation: the formation is primarily of tertiary sedimentary rock introduced by quartz-diorite.

Instrumentations:

Name: World-Wide Standard Seismograph

Magnification of components:

Short period (1 second), vertical: 100,000
Short period (1 second), north-south: 100,000
Short period (1 second), east-west: 100,000
Long period (15 second), vertical: 3,000
Long period (15 second), north-south: 3,000
Long period (15 second), east-west: 3,000

Complete Response Curve: attached figure 1.

Speed of Recording: Short period, 60 mm/minute; Long period, 15 mm/minute.

/...

Method of Recording: Bromide paper recording

Precision of Time: 0.1 second (by crystal clock)

Form of Recorded Copy: Contacted copy

2. Tsukuba Seismological Observatory (MTJ)

Earthquake Research Institute, the University of Tokyo,

Yayoi 1-1, Bunkyo-ku, Tokyo, JAPAN

Latitude: 36° 12' 39" N; Longtitude: 140° 06' 36" E; Elevation: 286 m;

Geological Foundation: Granite

Instrumentations:

(1) Anderson-Wood Torsion Seismograph
NS: T1 = 0.8 s, h = 0.8, V = 2,400 (ca 900 at 1 s)
EW: T1 = 0.8 s, h = 0.8, V = 2,000 (ca 750 at 1 s)
Recording: Bromide paper
Speed: 2 cm/min.
Time Marks: Minute, hour and 12 hour by crystal clock with $\Delta T = 0$ adjusted twice a day by eye and ear method.

(2) Ishimoto Acceleration Seismograph
NS: T1 = 0.11 s, h = 0.58, p = 0.04, V = 220 (ca 160 at 0.1 s)
EW: T1 = 0.12 s, h = 0.70, p = 0.05, V = 200 (ca 150 at 0.1 s)
UD: T1 = 0.10 s, h = 0.57, p = 0.05, V = 190 (ca 220 at 0.1 s)
Recording: Smoked paper
Speed: 12 cm/min.
Time Marks: same as (1)

(3) Hagiwara Inverted Pendulum Seismograph
NS: T1 = 5.0 s, h = 0.64, p = 0.47, V = 34 (ca 38 at 1 s)
EW: T1 = 5.0 s, h = 0.60, p = 0.45, V = 34 (ca 38 at 1 s)
Recording: Smoked paper
Speed: 12 cm/min.
Time Marks: same as (1)

(4) HES 1-0.2 Seismograph
NS: T1 = 1.00 s, T2 = 0.18 s, h1 = h2 = 1.0, Vmax = 132 K at 0.2 s (23 K at 1 s) on the film viewer
EW: T1 = 1.03 s, T2 = 0.16 s, h1 = h2 = 1.0, Vmax = 127 K at 0.2 s (20 K at 1 s) on the film viewer
UD: T1 = 1.00 s, T2 = 0.21 s, h1 = h2 = 1.0, Vmax = 155 K at 0.2 s (31 K at 1 s) on the film viewer
Recording: 35 mm Film
Speed on the film viewer: 16 cm/min. (actual speed 2 cm/min.)
Time Marks: same as (1)

(5) HES 1-1 Seismograph
NS: T1 = 1.00 s, T2 = 1.11 s, h1 = h2 = 1.0, Vmax = 50 K at 0.7 s (42 K at 1 s) on the film viewer
EW: T1 = 1.00 s, T2 = 1.41 s, h1 = h2 = 1.0, Vmax = 50 K at 0.7 s (42 K at 1 s) on the film viewer
UD: T1 = 0.94 s, T2 = 1.08 s, h1 = h2 = 1.0, Vmax = 50 K at 0.7 s (42 K at 1 s) on the film viewer
Recording: 35 mm Film
Speed on the film viewer: 16 cm/min. (actual speed 2 cm/min.)
Time Marks: same as (1)

(6) HES 1-20 Seismograph
NS: T1 = 1.0 s, T2 = 20.7 s, h1 = 3.0, h2 = 1.0, Vmax = 1880 at 1.0 s (280 at 20 s) on the film viewer
EW: T1 = 1.0 s, T2 = 22.4 s, h1 = 3.1, h2 = 1.0, Vmax = 1740 at 1.0 s (280 at 20 s) on the film viewer
UD: T1 = 1.0 s, T2 = 21.6 s, h1 = 2.3, h2 = 1.0, Vmax = 2330 at 1.0 s (280 at 20 s) on the film viewer
Recording: 35 mm Film
Speed on the film viewer: 16 cm/min. (actual speed 2 cm/min.)
Time Marks: same as (1)

(7) Columbia Long Period Seismograph
NS: T1 = 15.0 s, T2 = 102.0 s, Vmax = 1400 at 18 s (1400 at 20 s) on the seismogram
EW: T1 = 15.2 s, T2 = 93.0 s, Vmax = 1400 at 18 s (1400 at 20 s) on the seismogram
UD: T1 = 14.4 s, T2 = 90.0 s, h1 = 2.0, h2 = 1.2, Vmax = 700 at 14 s
Recording: Bromide paper
Speed: 1.5 cm/min.
Time Marks: same as (1)

Response Curve: Figure 2

Copies would be available after two weeks of the event by the users' request in appropriate copy forms, provided total amount is not extravagant. Copies for (7) are available from the Lamont Geological Observatory, Palisade, New York, after a month or so.

3. Shiraki Micro-Earthquake Observatory (SHK)

Earthquake Research Institute, the University of Tokyo

Yayoi 1-1, Bunkyo-ku, Tokyo, JAPAN

Latitude: 34° 31' 56" N; Longitude: 132° 40' 39" E Elevation: 285 m;

Geological Foundation: Granite

/...

Instrumentations:

(1) HES 1-0.2 Seismograph
NS: T1 = 1.00 s, T2 = 0.22 s, h1 = h2 = 1.00, Vmax = 50 K at 0.2 s (10 K at 1 s) on the film viewer
EW: T1 = 1.00 s, T2 = 0.24 s, h1 = h2 = 1.00, Vmax = 50 K at 0.2 s (10 K at 1 s) on the film viewer
UD: T1 = 1.00 s, T2 = 0.21 s, h1 = h2 = 1.00, Vmax - 50 K at 0.2 s (10 K at 1 s) on the film viewer
Recording: 35 mn Film
Speed on the film viewer: 16 cm/min. (actual speed 2 cm/min.)
Time Marks: Minute, Hour and 12 hour by crystal clock with $\Delta T = 0$ adjusted twice a day by eye and ear method.

(2) Benioff Short Period Seismograph (WWSSN)
NS: T1 = 1.00 s, T2 = 0.75 s, h1 = 0.67, h2 = 1.00, Vmax = 13,750 at 0.6 s (10,200 at 1 s) on the seismogram
EW: T1 = 1.00 s, T2 = 0.75 s, h1 = 0.67, h2 = 1.00, Vmax = 13,750 at 0.6 s (10,200 at 1 s) on the seismogram
UD: T1 = 1.00 s, T2 = 0.75 s, h1 = 0.67, h2 = 1.00, Vmax - 18,750 at 0.6 s (10,200 at 1 s) on the seismogram
Recording: Bromide paper
Speed: 6 cm/min.
Time Marks: same as (1)

(3) Sprengnether Long Period Seismograph (WWSSN)
NS: T1 = 15.0 s, T2 = 100 s, h1 = h2 = 1.00, Vmax = 1,500 at 15 s (1,400 at 20 s) on the seismogram
EW: T1 = 15.0 s, T2 = 100 s, h1 = h2 = 1.00, Vmax = 1,500 at 15 s (1,400 at 20 s) on the seismogram
UD: T1 = 15.0 s, T2 = 100 s, h1 = h2 = 1.00, Vmax = 1,500 at 15 s (1,400 at 20 s) on the seismogram
Recording: Bromide paper
Speed: 3 cm/min
Time Marks: same as (1)

Copies for (2) and (3) are available from the Coast and Geodetic Survey, ESSA, WWSSN Data Center after several months. Contact film copies for (1) are always available at SHK.

4. Wakayama Micr-Earthquake Observatory

Earthquake Research Institute, the University of Tokyo

Yayoi 1-1, Bunkyo-ku, Tokyo, JAPAN

OIS (Oishi-yama Telemeter): Latitude 34° 05' 35.1"N; Longitude: 135° 18' 42.4" E; Elevation 776 m; Geological Foundation: Crystalline schist

WKU (Waka-ura): Latitude 34° 11' 16.5" N; Longitude 135° 10' 22.7" E; Elevation: 10 m; Geological Foundation: Crystalline schist

/...

Instrumentations:

(1) Radio Telerecording Seismograph RTS-V at OIS
NS: Tl = 1 s, Vmax = 104 K at 0.05 s (ca 8 K at 1 s)
EW: Tl = 1 s, Vmax = 104 K at 0.05 s (ca 8 K at 1 s)
UD: Tl = 1 s, Vmax = 208 K at 0.05 s (ca 16 K at 1 s)
Recording: Ink writing drum paper
Speed: 4 mm/s
Time Marks: Hour, Minute and Second marks are given by crystal clock with $\Delta T = 0$ adjusted automatically by short-wave time signal broadcasting JJY from Tokyo Astronomical Observatory, together with the hour marks by the medium-wave broadcasting of NHK.

(2) Electronic Short Period Seismograph at WKU
NS: Tl = 1 s, Vmax = ca 42 K at 0.05 s (ca 3.5 K at 1 s)
EW: Tl = 1 s, Vmax = ca 48 K at 0.05 s (ca 4.0 K at 1 s)
UD: Tl = 1 s, Vmax = ca 66 K at 0.05 s (ca 3.5 K at 1 s)
Recording: Ink writing drum paper
Speed: 4 mm/s
Time Marks: same as (1)
Response curve: Figure 3

Contact copies are always available at Wakayama Micro-earthquake Observatory, 685 Wakaura, Wakayama-shi, Wakayama-ken, JAPAN.

5. Kochi Earthquake Observatory

Kochi University, Faculty of Literature and Science

Doi, Ugurusu, Asakura, Kochi-shi, Kochi-ken, JAPAN

URS (Ugurusu): Latitude 33° 32' 15.2" N; Longitude 133° 29' 18.9" E; Elevation: 20 m; Geological Foundation: Chert

WMY (Wakamiya): Latitude 33° 38' 31.7" N; Longitude 133° 40' 30.2" E; Elevation: 23 m; Geological Foundation: Limestone

IHR (Ishihara): Latitude 33° 41' 16.6" N; Longitude 133° 28' 16.2" E; Elevation: 51 m; Geological Foundation: Quartz Porphyries

Instrumentations:

Short Period Electronic Seismograph
URS: Tl = 1 s, Vmax = 1 K for 1.5-20 HZ (ca 0.7 K at 1 s)
WMY: Tl = 1 s, Vmax = 2 K for 1.5-20 HZ (ca 1.4 K at 1 s)
IHR: Tl = 1 s, Vmax = 2 K for 1.5-20 HZ (ca 1.4 K at 1 s)
(same for NS, EW and UD)
Recording: Ink writing drum paper
Speed: 4 mm/s
Time Marks: Hour, Minute and Second marks given by the crystal clock of the accuracy 10^{-6} with hour time signal broadcasting of the NHK, which can allow to evaluate ΔT.
Response curve: Figure 4

Contact copies are available from the Observatory.

/...

B. Array Stations

Dodaira Micro-Earthquake Observatory

Earthquake Research Institute, the University of Tokyo

Yayoi 1-1, Bunkyo-ku, Tokyo, JAPAN

DDR: Latitude 35° 59' 54" N; Longitude 139° 11' 36.2" E; Elevation 800 m;
Geological Foundation: Paleozoic Chert

TSK: Latitude 36° 12' 29" N; Longitude 140° 06' 35" E; Elevation 230 m;
Geological Foundation: Granite

KYS: Latitude 35° 11' 51" N; Longitude 140° 08' 53.6" E; Elevation 180 m;
Geological Foundation: Tertiary

SRY: Latitude 35° 36' 30" N; Longitude 139° 16' 27" E; Elevation 254 m;
Geological Foundation: Paleozoic Chert

Geometry: Figure 5 shows an irregular large array and figure 6 a small array at DDR. Information is telemetered by radio to Tokyo.

Instrumentations:

(1) Ultra-long Period or Broad Band Seismograph at DDR
NS, EW, UD: T1 = 10 s, V = ca 60 at 5-150 s
(Equivalent constants: T1 = 10 s, T2 = 360 s, h1 = 12, h2 = 1)
Recording: Ink writing 3 components parallel chart with paper speed: 15 mm/min.
Time Marks: Minute and hour marks are given by a digital clock with t = 0 adjusted automatically by JJY.

(2) Long Period Seismograph at DDR
NS, EW: T1 = 15 s, Vmax = 900 and 90 (at 15-20 s)
UD: T1 = 15 s, Vmax = 750 and 75 (at 15-20 s)
(Equivalent constants: T1 = 15 s, T2 = 90 s, h1 = h2 = 1)
Recording: Ink writing drum
Paper speed: 15 mm/min.
Time Marks: same as (1)

(3) Medium Period Seismograph at DDR
NS, EW, UD: T1 = 5.0 s, h = 0.7, V = 1.8 K at 1 s
Recording: Parallel trace of 16 mm Film Develocorder
Speed: 30 mm/min. (600 mm/Min. on the viewer)
Time Marks: same as (1) and parallel trace of 10 second, minute and hour marks from the same clock with time cord at every 10 minutes.

(4) Medium Period Seismograph at TSK
UD: T1 = 15 s, h = 0.7, V = 22 K at 1 s
Recording: Ink writing drum
Speed: 60 mm/min.
Time Marks: same as (1)

/...

(5) Short Period Seismograph at DDR

(a) NS, EW, UD (at Vaults No. 5): T1 = 1 s, h = 1.0, V = 36 K at 1 s
Recording: Ink writing drum
Speed: 60 mm/min.
Time Marks: same as (1)

(b) NS, EW, UD (Filtered Sum)
Recording: Parallel trace ink writing chart
Speed: 60 mm/min
Time Marks: same as (1)

(c) UD (at Vault No. 1): T1 = 1 s, h = 1.0, V = 36 K at 1 s
Recording: Ink writing parallel trace chart together with UD at TSK, KYS and SRY.
Speed: 60 mm/min.
Time Marks: same as (1)

(d) NS, EW, UD (at Vaults Nos. 1-6): T1 = 1 s, h = 1.0, V = 36 K at 1 s
Recording: Triggered Magnetic Tape (discontinued but possible resumption)

(6) Short Period Seismograph at TSK

(a) UD: T1 = 1.0 s, h = 0.7, V = 14 K at 1 s
Recording: Parallel trace ink writing chart together with UD at DDR, KYS and SRY.
Speed: 60 mm/min.
Time Marks: same as (1)

(b) UD through band pass filters (figure 9)
Recording: 4 parallel trace ink writing chart
Speed: 60 mm/min.
Time Marks: same as (1)

(7) Short Period Seismograph at KYS
NS, EW, UD: T1 = 1.0 s, h = 0.5, V = 11 K at 1 s
Recording: (a) Parallel trace ink writing chart together with UD at DDR, TSK and SRY. Speed: 60 mm/min.
(b) Parallel trace 16 mm Film Develocorder. Speed: 30 mm/min. (600 mm/min. on the viewer)
Time Marks: (a) same as (1)
(b) same as (3)

(8) Short Period Seismograph at SRY
NS, EW, UD: T1 = 1.0 s, h = 0.5, V = 45 K at 1 s
Recording: (a) same as 7 (a)
(b) same as 7 (b)

All visible records are available on request to the Tokyo University."

/Figures 1-10 to the above communication - containing detailed information on Japan's seismic stations, namely - Frequency response curves of several seismographs of Japan; velocity sensitivity; displacement magnification; locations of Dodaira Seismological Observatory - are deposited in the archives of the United Nations and interested delegations may consult them upon request to the Disarmament Affairs Division./

/...

LUXEMBOURG

[Original: French]
22 April 1970

"... [transmitted] herewith [is] documentation on seismological observations made in the Grand Duchy of Luxembourg.

Copies of the records may be obtained from the Ministry of Cultural Affairs, Luxembourg.

SEISMIC STATION IN THE SAINT-ESPRIT CASEMATES, CITY OF LUXEMBOURG

A. The Luxembourg station

In pursuance of an agreement between the Government of the Grand Duchy of Luxembourg and the Royal Observatory of Belgium, a seismic station was established in the Saint-Esprit Casemates at Luxembourg. It went into operation on 1 May 1967.

A Brillié master clock, synchronized by a H.B.G. radio receiver, provides the time-base.

Technical data on the station:

(a) Geographical co-ordinates:

$\Psi = 49^\circ 36.0'$ N $\quad \lambda = 6^\circ 8.0'$ E

= elevation 270 m

(b) Instrumentation:

1 Masing-type Galitzine-Wilip vertical seismograph

T_p = 11.67 sec $\quad T_g$ = 11.65 sec $\quad l_r$ = 160 mm $\quad \Lambda$ = 1000 mm

2 Masing-type Galitzine-Wilip horizontal seismographs,

= one E-W component:

T_p = 12.38 sec $\quad T_g$ = 12.39 sec $\quad l_r$ = 95 mm $\quad \Lambda$ = 1000 mm

= one N-S component:

T_p = 12.46 sec $\quad T_g$ = 12.44 sec $\quad l_r$ = 95 mm $\quad \Lambda$ = 1000 mm

Number of seismic events recorded since the station went into operation (1 May 1967): 1,498 up to 30 September 1969.

/...

B. Bulletins of the Belgian and Luxembourg network

(a) The "Annual Bulletins" of the Uccle station for 1955-1965, those of the Dourbes station for 1958-1965 and those of the Warmifontaine station for 1964 and 1965 are now being printed. The distances and azimuths given in them are calculated by an IBM 1620 computer by the method of calculating the great geodesics on the international ellipsoid.

(b) The "Provisional Bulletins" of all stations in the network are published and distributed as quickly as possible.

C. Collaboration with international centres

(a) B.C.I.S., Strasbourg: The most recent data from each station in the network are sent twice weekly.

(b) U.S.C.G.S., Washington: The most recent data are sent by airmail twice weekly.

(c) I.S.R.C., Edinburgh: 4,057 punched cards for 1964 and 1965 have been sent to this Centre.

(d) O.R.B., Brussels: All the original records of the Luxembourg station are kept at the Royal Observatory at Brussels."

/Two maps of seismographs of Luxembourg attached to the above communication are deposited in the archives of the United Nations and interested delegations may consult them upon request to the Disarmament Affairs Division./

MADAGASCAR

/Original: French/
20 April 1970

"... /transmitted herewith is/ the technical information related to the seismic station of the Tananarive Observatory:

Seismic station of the Tananarive Observatory

I.	Name of station:	Tananarive Observatory Faculty of Sciences University of Madagascar P.O. Box 3843
II.	Geographical Co-ordinates:	Latitude: 18° 55' 02" S Longitude: 47° 33' 06" E Elevation: 1,375 metres

/...

III. Instrumentation:

1. Two mainka horizontal seismographs (E W - N S)	Period: 1.2 second Smoked-paper recording Recording speed: 19 mm/minute Gain: approximately 200
2. One Grenet vertical seismograph	Period: 1.49 second Galvanometer period: 0.8 second Photographic recording Recording speed: 1 mm/second Operational magnification: 4,200
3. One Rocard vertical seismograph	Period: 1 second Paper recording Recording speed: variable from 1 to 100 mm/second Present speed: 2.5 mm/second Maximum gain: 1,214,000 Operating gain: 75,900
IV. Geological description of the station foundation:	The station is situated on a granite dike.
V. Chronometric precision:	The hour and minute-sounding clock is synchronized to WWV. The maximum error is approximately 0.5 second in 24 hours.
VI. All records are deposited at the Tananarive Observatory, and we are prepared to send microfilms (24 x 36 mm) of the records to persons requesting them	

As an addition to our incomplete facility we plan to install a network of three stations each having a one-second-period Rocard vertical seismograph and a transceiver. This will enable us to make good wave recordings (background noise being very low since the stations are far from towns) and to determine precisely the location of an explosion centre and the time of firing. The project is under way but there is inadequate financing; a subsidy of 4,500,000 Malagasy francs for equipment would assist in the establishment of the facilities.

Annexes

[Figures 1 to 3 annexed to the above communication - containing a geological map of the seismic station site and seismograph response curves - are deposited in the archives of the United Nations and interested delegations may consult them upon request to the Disarmament Affairs Division.]

NEW ZEALAND

[Original: English]
27 April 1970

"... attached [is the] note conveying information as regards [seismic stations of] New Zealand as well as a list showing details of seismic stations located in New Zealand:

SEISMOGRAPH STATIONS

Records from all New Zealand-controlled seismograph stations have always been available for use by those with a valid scientific interest in them. It has not generally been found necessary to make available to those with an interest in overseas events records from all stations of the network, which is designed primarily for the location of local earthquakes, but rather to offer a selection of records from a few of the stations with higher magnification.

Suggested stations, both within and beyond New Zealand, from which records would be available are listed below. All requests for records from these stations should be addressed to:

The Superintendent,
Seismological Observatory, DSIR,
Box 8005,
WELLINGTON, New Zealand.

In general, if records are requested full-sized Zerox or photographic copies will be supplied, but in special circumstances original records may be borrowed. Records will be available for borrowing once preliminary analysis has been carried out, which will generally be within two weeks of the record being taken. Records from Scott Base (Antarctica) and Rarotonga (Cook Islands) may be subject to longer delays due to the infrequency of transport. It is requested that all original records be returned to Wellington within one month; copies may be kept indefinitely.

All records or copies will show minute marks impressed from a crystal clock, and will either have time corrections marked on the record (for World Network Stations) or have radio time-pips recorded. Recording speeds of 60 mm/min. are used for all short-period instruments, and either 30 or 15 mm/min. for long-period instruments of World Network Stations.

/...

Records from other stations of the New Zealand network, besides those mentioned below, may be made available if it can be shown that there is a special need for them. Lists of these stations and their positions and instruments are given in the New Zealand National Report to the International Association of Seismology and Physics of the Earth's Interior, and are supplied to all international agencies.

Copies of records from World Network Stations (AFI, RAR, WEL, SBA) are held by the United States Coast and Geodetic Survey in Washington, D.C., U.S.A. Other than this, it is not proposed to make New Zealand records available except when specifically requested.

The list of selected stations and their details is appended.

NEW ZEALAND-CONTROLLED SEISMOGRAPH STATIONS SUITABLE FOR THE STUDY OF DISTANT EVENTS

AFIAMALU (AFI) Western Samoa. World Network Station.

Lat. 13°54'34"S, Long. 171°46'38"W.
Altitude 706 metres.
Lithological foundation: Basaltic lava flows.
Instruments:

Benioff, ZNE. T_o = 1.0 sec, T_g = 0.75 sec.
Magnification 12,500 at 1.0 sec.

Press-Ewing, ZNE. T_o = 15 sec, T_g = 100 sec.
Magnification 750 at 15 sec.

RAROTONGA (RAR) Cook Islands. World Network Station.

Lat. 21°12'45"S, Long. 159°46'24"W.
Altitude 28 metres.
Lithological foundation: Basalt.
Instruments:

Benioff, ZNE. T_o = 1.0 sec, T_g = 0.75 sec.
Magnification 6,250 at 1.0 sec.

Press-Ewing, ZNE. T_o = 15 sec, T_g = 100 sec.
Magnification 375 at 15 sec.

KARAPIRO (KRP) North Island, New Zealand.

Lat. 37°55'30"S, 175°32'15"E.
Altitude 64 metres.
Lithological foundation: Greywacke.
Instrument:

Benioff, ZNE. T_o = 1 sec, T_g = 0.2 sec.
Magnification about 35,000 at 0.5 sec.

MANGAHAO (MNG) North Island, New Zealand.

Lat. 40°37'07"S, Long. 175°28'55"E.
Altitude 396 metres.
Lithological foundation: Greywacke.
Instrument:
Willmore II, Z. T_o = 1.0 sec, T_g = 1/4 sec.
Magnification 49,000 at 0.3 sec.

WELLINGTON (WEL) North Island, New Zealand. World Network Station.

Lat. 41°17'10"S, Long. 174°46'06E.
Altitude 122 metres.
Lithological foundation: Greywacke.
Instruments:
Benioff, ZNE. T_o = 1.0 sec, T_g = 0.75 sec.
Magnification 6,250 at 1.0 sec.
Press-Ewing, ZNE. T_o = 15 sec, T_g = 100 sec.
Magnification 750 at 15 sec.

MOUNT JOHN (MJZ) South Island, New Zealand.

Lat. 43°59'14"S, Long. 170°27'58"E.
Altitude 1,000 metres.
Lithological foundation: Greywacke.
Instrument:
Willmore II, ZNE. T_o = 1 sec, T_g = 1/4 sec.
Magnification 30,000 at 1/4 sec.

MILFORD SOUND (MSZ) South Island, New Zealand.

Lat. 44°40'14"S, Long. 167°55'01"E.
Altitude 38 metres.
Lithological foundation: Gneiss.
Instrument:
Willmore II, Z. T_o = 1 sec, T_g = 1/4 sec.
Magnification 53,000 at 1/4 sec.

SCOTT BASE (SBA) Antarctica. World Network Station.

Lat. 77°51'01"S, Long. 166°45'22"E.
Altitude 38 metres.
Lithological foundation: frozen Basaltic debris resting on lava flows.
Instruments:
Benioff, ZNE. T_o = 1.0 sec, T_g = 0.75 sec.
Magnification 6,250 to 25,000 at 1 sec.
Press-Ewing, ZNE. T_o = 15 sec, T_g = 100 sec.
Magnification 750 to 1,500 at 15 sec.

PAKISTAN

[Original: English]
27 April 1970

[enclosed is] an information sheet along with graphs in regard to conventional seismograph stations in Pakistan. There are no array stations in Pakistan.

[The additional information on Pakistan's seismic stations, attached to the above communication, namely - frequency response of short period Benioff Seismograph Quetta; frequency response of long period Sprengnether Seismograph Quetta; frequency response of short period Benioff seismograph, Nilore; frequency response of long period Sprengnether seismograph, Nilore - is deposited in the archives of the United Nations and interested delegations may consult it upon request to the Disarmament Affairs Division.]

CONVENTIONAL SEISMOGRAPH STATIONS IN PAKISTAN

ENCLOSURE I

S.No.	REQUIRED INFORMATION										ADDITIONAL INFORMATION	
	Name of Station	Name and address of the operating organization.	Coordinates	Elevation	Instruments	Period of Seismometer	Period of Galvanometer	Components Recorded	Speed of recording	Geographical description of the station foundation.	Magnification	Timing system
1.	QUETTA	Director, Pakistan Meteorological Department, Blocks 1-3, Frere Road, Karachi-Pakistan Through Deputy Director, Geophysical Centre, Post Box No.2, Quetta - Pakistan.	Lat. 30°11'N Long. 66°57'E	1721 Meters	i) Worldwide Benioff 3-Component short-period Seismograph.	1.0 sec. 1.0 sec. 1.0 sec.	0.75 sec. 0.75 sec. 0.75 sec.	Vertical (Z) North-South (NS) East-West (EW)	60 mm/minute 60 mm/minute 60 mm/minute	Cretaceous limestone	2,00,000 2,00,000 2,00,000	The frequency controlled electronic clock of the World-wide time and power console housing the above timing system, power supplies, radio receiver and calibration unit.
					ii) Worldwide Sprengnether. 3-Component long-period seismograph.	15.1 sec. 15.0 sec. 14.8 sec.	100.0 sec. 100.0 sec. 100.0 sec.	Vertical (Z) North-South (NS) East-West (EW)	15 mm/minute 15 mm/minute 15 mm/minute		6,000 6,000 6,000	
2.	MILORE Rawalpindi	As above	Lat: 33°39'N Long: 73°15'E	536 Meters	i) World-wide Benioff 3-component short-period Seismograph.	1.0 sec. 1.0 sec. 1.0 sec.	As above	As above	As above	Calcareous sandstone	1,00,000 1,00,000 1,00,000	
					ii) World-wide Sprengnether 3-Component Long-period seismograph.	15.0 sec. 15.0 sec. 15.0 sec.					3,000 3,000 3,000	As above.

Response Curves are attached

PORTUGAL

[Original: English/Portuguese]

"... herewith [is] the information from the Government of Portugal required by General Assembly resolution 2604 A (XXIV), concerning Portuguese seismic stations, which has been drawn up by the 'Instituto Geofísico do Infante D. Luís' of the Faculty of Science of Lisbon:

LIST OF PORTUGUESE CONVENTIONAL SEISMIC STATIONS WHICH COULD PROVIDE INFORMATION IN CONNEXION WITH A COMPREHENSIVE NUCLEAR TEST BAN

1. Oporto Seismic Station

Address: Instituto Geofísico da Universidade do Porto Serra do Pilar, Vila Nova da Gaia

Co-ordinates: Lat. 41°8'19" N Long. 8°36'8" W

Elevation: 88 metres

Foundation: Granite

Instrumentation: 3 Benioff seismometers with period set at 1 sec and galvanometers at 0.8 sec.

Speed of recording: 60 mm/min

3 Sprengnether seismometers with period set at 15 sec and galvanometers at 100 sec

Speed of recording: 30 mm/min

Magnification at 1 sec = 50K; magnification at 20 sec = 3K

These instruments went into operation on 10 March 1963.

The station is part of the world-wide standard seismograph network (WWSSS).

2. Coimbra Seismic Station

Address: Instituto Geofísico da Universidade de Coimbra, Coimbra.

Co-ordinates: Lat. 40°12'25" N Long. 8°25'30" W

Elevation 140 metres

Foundation: Sandstone

Instrumentation: 1 Grenet vertical seismometer at 1.4 sec and a galvanometer at 0.75 sec

Maximum magnification approximately 8K at t = 0.63 sec

/...

This instrument went into operation on 22 January 1961.

The station is to be remodelled with a view to installing seismographic instrumentation more suitable for work in connexion with nuclear tests.

3. Lisbon Seismic Station

Address: Instituto Geofísico do Infante D. Luis
Faculdade de Ciencias de Lisboa
Rua da Escola Politícnica, Lisbon

Co-ordinates: Lat 38°42'59.4" N Long. 9°8'56.7" W
Elevation 77 metres

Foundation: Calcareous

Instrumentation: 1 Sprengnether seismometer at 1.5 sec and a galvanometer at 1.5 sec
Magnification: approximately 3,500 for t = 1 sec
Speed of recording: 30 mm/m

This instrument went into operation on 21 March 1954

A Geotech seismometer has been purchased which, when installed, will enable the station to meet requests for information on nuclear tests more effectively.

4. Ponta Delgada (Azores) Seismic Station

Address: Serviço Meteorológico Nacional
R. Saraiva de Carbalho, 2
Lisbon

Co-ordinates: Lat. 37°44'36" N Long. 25°39'42" W
Elevation: 35 metres

Foundation: Volcanic ash and lava

Instrumentation: 3 Benioff seismometers at 1 sec and galvanometers at 100 sec
Speed of recording: 15 mm/min
Magnification at 1 sec (6,250 (summer) (3,125 (winter)
Magnification at 15 sec (750 (summer) (375 (winter)

These instruments went into operation in April 1962.

This station is part of the world-wide standard network (WWSSS).

/...

5. Sá da Bandeira Seismic Station (Angola)

Address: Serviço Meteorológico de Angola
Luanda, Angola

Co-ordinates: Lat. 14°55'33" S Long. 13°34'19" E
Elevation 1,781 metres

Foundation: Granite

Instrumentation: 3 Benioff seismometers at 1 sec and galvanometers at 0.9 sec
Speed of recording: 60 mm/min
3 Sprengnether seismometers at 15 sec and galvanometers at 100 sec
Speed of recording: 30 mm/min

These instruments went into operation in October 1964.

6. Changalane Seismic Station (Mozambique)

Address: Serviço Meteorológico de Moçambique
Lourenço Marques, Mozambique

Co-ordinates: Lat. 26°17'30" S Long. 32°11'18" E
Elevation 100 metres

Foundation: Weathered basalts

Instrumentation: 1 Benioff seismometer at 1 sec with 1 galvanometer at 0.2 sec and 1 galvanometer at 82 sec for recording from the vertical component (installed in September 1961).
2 horizontal Benioff seismometers at 1 sec with galvanometers at 0.2 sec and 90 sec for recording from the horizontal components (installed in January 1964).
Speed of recording: 60 mm/min (short period) and 30 mm/min (long period)."

SINGAPORE

[Original: English]
24 April 1970

"... there is no seismic station in Singapore."

/...

SWEDEN

/Original: English/
23 April 1970

... /transmitted/ herewith /is/ the required information about the seismological stations from which the Swedish Government would be prepared to supply records of guaranteed availability in a world-wide exchange of seismological data, to facilitate the achievement of a comprehensive test ban.

The seismic data from university operated seismograph stations in Sweden have traditionally been available to interested scientists and are expected to be so also in the future.

The Department for Goedesy at the Royal Institute for Technology in Stockholm operates there a conventional three-component short period seismograph station, but bulletins and record copies are at present not routinely available. The Seismological Institute at Uppsala University, Uppsala, operates six conventional seismograph stations, with the following specifications:

Stations, geographic co-ordinates, altitude, ground:	Seismograph:	Period of seismometer and galvanometer		Maximum dynamic magnification
Uppsala:	Short-period:			
59°51.5'N,17°37.6'E;	Benioff E'	1.0	0.7	60,000
14 m; granite	" N'	1.0	0.7	70,000
	" Z'	1.0	0.7	40,000
	Long-period:			
	Benioff E	1.0	74	2,810
	" N	1.0	87	2,600
	" Z	1.0	76	1,660
	Weichert E	11	--	185
	" N	10	--	181

U Thant
Secretary-General of the United Nations
NEW YORK

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Stations, geographic co-ordinates, altitude, ground:	Seismograph:	Period of seismometer and galvanometer		Maximum dynamic magnification
	Ultra-long-period:			
	Press-Ewing E	15	87	1,860
	" N	15	81	1,570
	" Z	15	85	1,700
	Press-Ewing Z (visible)	15	100	1,200
Kiruna: 67°50.4'N,20°25.0'E; 390 m; porphyry	Short-period:			
	Grenet-Coulomb Z'	1.3	0.7	13,810
	Long-period:			
	Galitzin E	12	12	760
	" N	13	12	820
	" Z	8	12	660
	Ultra-long-period:			
	Press-Ewing Z (visible)	15	100	1,200
Skalstugan: 63°34.8'N,12°16.8'E; 580 m; gneiss	Short-period:			
	Grenet-Coulomb Z'	1.4	0.8	14,500
Umeå: 63°48.9'N,20°14.2'E; 16 m; mica gneiss and pegmatite	Short-period:			
	Benioff E'	1.0	0.7	75,000
	" N'	1.0	0.7	75,000
	" Z'	1.0	0.7	75,000
	Ultra-long-period:			
	Press-Ewing E	15	100	5,500
	" N	15	100	5,500
	" Z	15	100	5,500
Uddeholm: 60°05.4'N,13°36.4'E; 240 m; granite	Short-period:			
	Grenet-Coulomb Z'	1.4	0.7	12,990
Delary: 56°28.3'N,13°52.1'E; 150 m; granite	Short-period:			
	Grenet-Coulomb Z'	1.4	0.7	13,510

The Seismological Institute supplies, by mail and on request, with a few days' delay a weekly bulletin of preliminary readings at Uppsala, with about six months' delay a detailed monthly bulletin for all six stations and finally a

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yearly bulletin. The Institute also provides, by cable, daily readings from Uppsala and Kiruna to the United States Coast and Geodetic Survey and, by daily air mail, Uppsala readings to Bureau Central International de Sèismologie. Records are kept indefinitely and copies, on 16 mm photographic film, are available on request to the Institute. Professor M. Båth is director of the Institute and its mailing address is Seismological Institute, 75120 Uppsala, Sweden. The telephone number is Uppsala 130258.

As a special contribution towards a better understanding of the control problems connected with a treaty banning nuclear weapon tests the Swedish Government has established a seismological array station, the Hagfors Observatory in central western Sweden. It is intended for research purposes and its data are already now available for data exchange. The Swedish Government would be prepared to guarantee availability of seismic records made by Hagfors Observatory or some equivalent or improved modification of it.

A technical description of the station and the data available is given below. The detailed arrangements at Hagfors are, however, subject to changes, as technical considerations may require.

Location

The Hagfors Observatory (HFS) employs three substations at geographical co-ordinates:

Gunnerudssätern (Gu)	N 60°08'03"	E 13°41'44"	265 m	m.s.l.
Äppelbo (Ae)	60°32'20"	13°55'41"	354 m	m.s.l.
Stöllet (St)	60°28'32"	13°19'11"	420 m	m.s.l.

The substations are on granite of the Baltic shield.

Substation links

Substations Ae and St are unmanned outstations linked by radio telemetry for recording at the manned substation Gu.

Instrumentation

All substations have one vertical short period seismometer in a shallow borehole in the bedrock and one vertical long period high sensitivity seismometer in a pressure tight underground vault on the bedrock. At Gu there are also

/...

N and E horizontal long period sensitivity seismometers in vaults. The short period instruments are Geotech model S-14 and Geotech model S-13, with 0.95 seconds/period. The long period instruments are Geotech model S-11 and S-12, with 20 seconds/period. Their nomiral response curves are as follows:

SP seismometers

Frequency	Sensitivity
Hz	mV/μ
0.6	$2.0 \cdot 10^3$
0.8	$6.0 \cdot 10^3$
1.1	$9.2 \cdot 10^3$
1.5	$6.0 \cdot 10^3$
2.1	$2.0 \cdot 10^3$

LP seismometers

Period	Sensitivity	
	filtered	unfiltered
s	mV/μ	mV/μ
10	$1.6 \cdot 10^1$	$6.0 \cdot 10^1$
14	$4.0 \cdot 10^2$	$8.6 \cdot 10^1$
17	$9.5 \cdot 10^2$	$1.2 \cdot 10^2$
22	$1.3 \cdot 10^3$	$1.5 \cdot 10^2$
30	$9.2 \cdot 10^2$	$1.1 \cdot 10^2$
50	$2.5 \cdot 10^2$	$3.0 \cdot 10^1$
70	$8.2 \cdot 10^1$	$1.0 \cdot 10^1$

Actual response curves are supplied with the record copies. The average short period noise at about 1 cps is 25 mμ p-p and the long period noise at about 20 seconds period is 120 mμ p-p.

Cluster

At Gu there is also a cluster of five short period vertical instruments in subsurface vaults on bedrock or in shallow boreholes, arranged in a 1 km diameter circle and feeding into an automatic detector. These seismometers are also of the Geotech model S-13 and S-14.

/...

Digital magnetic tape output

All seismometer outputs are digitally sampled, on-line, the short period instruments 10 times/second and the long period instruments once/second. The samples have 14 bits, corresponding to a 80 dB dynamic range. All samples, together with timing information, are recorded at Gu on 9 channel IBM compatible 1/2" digital magnetic tape, with 800 bpi packing density. This output amounts to at present one 2,440 ft tape/day and constitutes a main product of the station.

Analog magnetic tape output

Short and long period vertical seismograph signals from all three substations are also continuously recorded at 0.06 inches/second on 14 channel 1" analog IRIG standard magnetic tape, frequently modulated at 54 cps centre frequency. The band width is 10 cps and the dynamic range 40 dB/channel. This output amounts to about one 3,600 ft tape/week.

Visual monitoring

For visual monitoring at Gu the automatic detector, one short period vertical and all long period instruments are also continuously strip-recorded on paper, with 0.2 mm/second. This output is about 17 m paper/day.

Automatic detector output

The detector ring seismometer outputs are fed through narrow analog filters (2-5 cps) to the automatic detector, which tests them for arrival time coincidence and selects events with apparent surface velocities above 8 km/second and above an adjustable amplitude level. This selection is not sensitive to source azimuth. Upon detection of an event, analog strip-recording on paper of seven short period outputs and of detector and time information is started. Using the analog magnetic tape as a data buffer, the strip-recording starts 10 seconds before event detection and is held at 20 mm/second during the first 65 seconds and then at 2 mm/second for 160 seconds, then it ends. A new cycle is started if a new arrival occurs during these 160 seconds. This output amounts to, as an average, ten to fifteen events/day. The automatic detector arrival times and peak vertical amplitudes at about 3 cps are also automatically printed by a typewriter.

Process control

System operation is co-ordinated by a Raytheon 703 computer with a 16 bits by 4 k memory. In- and output is by magnetic tape, perforated tape and typewriter. Operator commands may be entered by sense switches.

Calibration

At Gu there is daily pulse calibration of the seismographs there, period and mass position checks for long period instruments and checks of local clocks against radio time signals. At outstations St and Ae calibration is made once/week.

Editing and analysis

The recorded data are sent in weekly batches to an analysis group at the Institute in Stockholm for playback and for manual and computer analysis of selected events.

Availability of record copies

(a) Digital recordings from Hagfors' substations, by short and long period vertical and horizontal seismometers, on 9 track 800 bpi digital magnetic tape, as obtained from IBM 360/75 or equivalent computers, available at nominal cost, on request to Stockholm one week but not later than 30 days after recording, with calibration data, format description etc.

(b) Analog recordings, on 14 channels IRIG magnetic tape, of short and long period vertical traces from Hagfors' substations Gu, Ae and St. Copies available on request to Stockholm within 3 months of recording, at nominal cost.

(c) Paper playout of analog magnetic tapes as in (b) above, for selected events, on request to Stockholm within 3 months of recording, at cost.

Availability of edited data

(a) Detector readings

Vertical short period signal arrival times and amplitudes, as seen by the automatic detector at Gu, are teletyped in batches within 24 hours from Hagfors to Stockholm and are available on request to Stockholm. Daily teletyped distribution from Hagfors can also be arranged.

/...

(b) Visual readings

Fixed format routine, giving short and long period arrival times, amplitudes and periods, visually read from analog monitor outputs of vertical instruments at the Hagfors' substations Gu, Ae and St. Gives also very rough epicenters as obtained from apparent velocity and direction over the array and estimated body and surface wave magnitudes. Prepared with one week's delay in Stockholm, for all events automatically detected by Hagfors. Available on request to Stockholm.

(c) Preliminary epicentre determinations

Computer runs to improve rough epicentre from visual readings, using extraneous arrival times, as received from a fixed selection of stations. Performed as needed in Stockholm, results available on request.

(d) Computer readings

Flexible content and fixed format off-line routine for events selected in Stockholm among visual readings, computed from digital tapes recorded at Hagfors' substations. Comprising Fourier transforms of signals, spectral body and surface magnitudes, revised locations, long period chirp filter searches, short, medium and long period spectral ratios, complexities etc. Produced in monthly batches, not yet available on request.

Management

Hagfors Observatory is operated by the Research Institute of the Swedish National Defense in Stockholm, Sweden.

Dr. Ola Dahlman is director of the Hagfors Observatory. His mailing address is:

FOA 478
S-104 50 Stockholm 80
Telephone: Stockholm 63 18 00/788
Teletype: 10366 foa stockholm, attention section 478."

/...

UNITED STATES OF AMERICA

[Original: English]
1 May 1970

"... [herewith is] a list of seismic stations from which the United States Government would be prepared to supply records, together with certain requested information about each station.

As is requested in the annex to resolution 2604 A, the lists of stations and pertinent information are broken into two categories - the 29 conventional seismograph stations of the World-Wide Standard Seismograph Network, which are dealt with in Appendix I; and the two array stations, which are treated in Appendix II. After events of interest, records from these stations are normally available within several days (in the case of array stations) and within between two weeks and several months (in the case of the conventional seismograph stations). As indicated in the appendices, these records will continue to be deposited in appropriate centres in the United States, and will continue to be available from these centres at cost for all interested parties.

Records from the seven listed United States Government conventional seismograph stations would be provided on the basis of guaranteed availability as long as these stations are maintained in operation. Since the United States Government has no present legislative authority to regulate the activities of the 22 non-governmental conventional seismograph stations listed, the guarantee that data from these stations would be available is based on their present practice, and would need to be reaffirmed by the private authorities concerned if their voluntary co-operation were to become a binding commitment.

The two United States Government-owned and operated array stations are research organizations. Consequently, no long-term commitment is possible. Data would be furnished as long as the arrays are in operation provided, of course, that changes in the data format, instrumentation, and configuration of the arrays may prove necessary in view of their experimental nature; and provided that interruptions in the flow of data might result from maintenance and improvement work.

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In addition to the stations listed in Appendix I, there are a number of conventional seismograph stations on United States territory from which records might be made available upon special request. These stations have not been included in Appendix I because for technical or budgetary reasons they do not routinely provide their records to seismological data centres.

APPENDIX I

Conventional Seismograph Stations

Table 1 of this appendix lists seismic stations from which the United States is prepared to supply records on the basis of guaranteed availability as long as these stations are in operation. All of these stations are part of the World-Wide Standard Seismograph Network (WWSSN) and all use three-componenent long-period seismometers of the Sprengnether type and three-component short-period seismometers of the Benioff type. All short-period instruments record at a speed of 60mm per minute and all long-period instruments record at a speed of 15mm per minute. All stations use the WWV time standard, resulting in a time precision of from several msec to 10 msec. Figure 1 gives response curves for the short-period and long-period instruments. The appropriate curve to use for each instrument can be found by entering the ordinate with the operational magnification from Table 1 and the abscissa with the appropriate period (1 second or 15-20 seconds). Additional details for each of the stations in Table 1 can be found in the Handbook: World-Wide Standard Seismograph Network, prepared for United States Coast and Geodetic Survey by the University of Michigan, (Rev. July 1966).

Fully annotated records from the stations in Table 1 would be provided on request. Seismograms are currently being sent to the ESSA National Geophysical Data Center (Asheville, North Carolina) from the C & GS stations on a three-week schedule and from the non-C & GS stations with a maximum delay of about six months. Full-size paper copies, 35mm film rolls or 70mm film chips are available at cost to interested parties.

APPENDIX II

Seismic Array Stations

The United States is prepared to supply records of selected seismic events recorded by the Large Aperture Seismic Array (LASA) and the Alaskan Long-Period Array (ALPA), details of which are presented in the two attachments to this appendix. Copies of records from these arrays can be made available at cost to any interested parties within several days after events occur. Under current practice, the records are available for at least one year at the United States Seismic Array Analysis Center, Washington, D.C.

TABLE 1. U.S. STATIONS OF THE WORLD-WIDE STANDARD SEISMOGRAPH NETWORK

LOCATION OF STATION	NAME OF OPERATING ORGANIZATION	ADDRESS OF OPERATING ORGANIZATION	STATION COORDINATES	STATION ELEVATION (Meters)	OPERATIONAL MAGNIFICATION (Vertical)*	GEOLOGICAL DESCRIPTION OF STATION FOUNDATION
Ann Arbor, Mich. (AAM)	Univ. of Michigan	Dr. Henry Pollack Dept. of Geology and Minerology, Univ. of Michigan Ann Arbor, Michigan 48107	42° 17' 59" N 83° 39' 22" W	254	SP: 25,000 LP: 1,500	200 feet of glacial drift (gravel) overlaying 800 feet of shale, which overlays 4800 feet of limestone. Granite is found 5670 feet below the surface.
Albuquerque, New Mexico (ALQ)	U.S. Coast and Geodetic Survey	U.S. Dept. of Commerce ESSA Coast and Geodetic Survey Rockville, Maryland 20852	34° 56' 30" N 106°27' 30" W	1853	SP: 200,000 LP: 3,000	Mostly limestone resting on metasediments and granitic intrusives. The seismometers are in an underground vault in one of the granites.
Atlanta, Georgia (ATL)	Georgia Institute of Technology	Minerals Engineering Group Engineering Experiment Sta. Georgia Institute of Tech. Atlanta, Georgia 30332	33° 26' 0" N 84° 20' 15" W	273	SP: 50,000 LP: 1,500	Vault is on a granite gneiss of the Georgia Piedmont.
Balboa Heights, Canal Zone (BHP)	Panama Canal Co.	Panama Canal Co. Balboa Heights Panama Canal Zone	8° 57' 39" N 79° 33' 29" W	36	SP: 12,500 LP: 750	Undisturbed rhyolite.
Berkeley, Cal. (BKS)	Univ. of California	Byerly Seismographic Station Univ. of California 475 Earth Sciences Bldg. Berkeley 4, California	37° 52' 36" N 122°14' 06" W	276	SP: 25,000 LP: 3,000	Cherts and shales of the Claremont Formation.
Blacksburg, Virginia (BLA)	Virginia Polytechnic Institute	Dr. C. E. Sears Box 522 Blacksburg, Virginia	37° 12' 41" N 80° 25' 14" W	634	SP: 50,000 LP: 3,000	Cambrian dolomite.
Bozeman, Montana(BOZ) (to be moved to Missoula, Montana in 1970)	Montana State Univ.	Geology Department Montana State Univ. Missoula, Montana	45° 36' 00" N 111° 37' 55" W	1575	SP: 200,000 LP: 3,000	Seismometers rest on bedrock (a folded complex of Pre-Cambrian gneiss and schist).

(Continued)

LOCATION OF STATION	NAME OF OPERATING ORGANIZATION	ADDRESS OF OPERATING ORGANIZATION	STATION COORDINATES	STATION ELEVATION (Meters)	OPERATIONAL MAGNIFICATION (Vertical)*	GEOLOGICAL DESCRIPTION OF STATION FOUNDATION
College Outpost, Alaska (COL)	U.S. Coast and Geodetic Survey	U.S. Dept. of Commerce ESSA Coast and Geodetic Survey Rockville, Maryland 20852	64° 54' N 147° 47' 36" W	312	SP: 100,000 LP: 1,500	Birch Creek schist.
Corvallis, Oregon (COR)	Oregon State Univ.	Dept. of Oceanography Oregon State University Corvallis, Oregon	44° 35' 08" N 123° 18' 11" W	123	SP: 12,500 LP: 750	First weathered layer of basaltic deposits.
Dallas, Texas (DAL)	Southern Methodist University	Dallas Seismological Observatory Southern Methodist Univ. Dallas 22, Texas	32° 50' 46" N 96° 47' 02" W	187	SP: 25,000 LP: 1,500	Station is underlain by about 150 feet of Upper Cretaceous Austin Formation limestone, 4000 feet of sandstone, shale and limestone of Cretaceous age, and Paleozoic rocks.
Dugway, Utah (DUG)	University of Utah	Dept. of Geophysics University of Utah Salt Lake City, Utah	40° 11' 42" N 112° 48' 48" W	1477	SP: 400,000 LP: 3,000	Solid granite.
Florissant, Missouri (FLO)	St. Louis, Univ.	St. Louis University Institute of Technology P.O. Box 8020 College Station St. Louis, Missouri 63156	38° 48' 06" N 90° 22' 12" W	160	SP: 50,000 LP: 3,000	Thick clay overlaying Mississippian bedrock.
Georgetown, D. C. (GEO)	Georgetown Univ.	Georgetown University Washington 7, D. C.	38° 54' N 77° 04' W	43	SP: 25,000 LP: 1,500	10 - 40 feet of weathered diorite overlaying Precambrian bedrock of granite, gneiss, schist and diorite.
Golden, Colo. (GOL)	Colorado School of Mines	Colorado School of Mines Golden, Colorado	39° 42' 01" N 105° 22' 16" W	2359	SP: 400,000 LP: 1,500	Precambrian rock (Idaho Springs formation).
Goldstone, Calif. (GSC)	California Institute of Technology	220 San Rafael Avenue Pasadena, California	35° 18' 06" N 116° 48' 18" W	990	SP: 100,000 LP: 1,500	Jack Spring quartz monzonite bedrock.
Guam, Mariana Islands (GUA)	U.S. Coast and Geodetic Survey	U.S. Dept. of Commerce ESSA Coast and Geodetic Survey Rockville, Maryland 20852	13° 32' 18" N 144° 54' 42" E	230	SP: 6,250 LP: 750	Fractured volcanic tuff.

(Continued)

LOCATION OF STATION	NAME OF OPERATING ORGANIZATION	ADDRESS OF OPERATING ORGANIZATION	STATION COORDINATES	STATION ELEVATION (Meters)	OPERATIONAL MAGNIFICATION (Vertical)*	GEOLOGICAL DESCRIPTION OF STATION FOUNDATION
Junction, Texas (JCT)	Texas A & M Univ.	Mr. E. D. Parrott Texas A & M Adjunct Junction, Texas	30° 28' 46" N 99° 48' 08" W	591	SP: 200,000 LP: 1,500	Exposed Cretaceous Edwards limestone.
Kipapa, Hawaii (KIP)	U.S. Coast and Geodetic Survey	U.S. Dept. of Commerce ESSA Coast and Geodetic Survey Rockville, Maryland 20852	21° 25' 24" N 158° 54' W	70	SP: 12,500 LP: 750	Weathered basalt of the Koolan Volcanic Series
Longmire, Washington (LON)	University of Wash.	Department of Geology Seismograph Station University of Washington Seattle 5, Washington	46° 45' N 121° 49' W	854	SP: 100,000 LP: 1,500	Well consolidated volcanics underlain by strata of granodiorite andesite and black argillite; basement rock is a granodiorite batholith.
Lubbock, Texas (LUB)	Texas Technological College	Seismological Observatory Texas Technological College Lubbock, Texas	33°35' N 101°52' W	980	SP: 25,000 LP: 1,500	Caliche overlaying Pleistocene deposits from 150 - 250 feet thick.
Ogdensburg, N. J. (OGD)	Columbia University	Lamont Geological Observatory Torrey Cliff Palisades, N. Y.	41° 04' N 74° 37' W	-373	SP: 50,000 LP: 750	Dolomitized white marble (Precambrian).
Oxford, Mississippi (OXF)	Univ. of Mississippi	Seismological Observatory University of Mississippi University, Mississippi 38677	34° 30' 43" N 89° 24' 33" W	101	SP: 50,000 LP: 3,000	Montmorillinite clay overlaying 600 feet of Cenozoic sediments and approximately 1500 feet of Mesozoic sediments.
Rapid City, South Dak. (RCD)	South Dakota School of Mines and Technology	Geology Department South Dakota School of Mines and Technology Rapid City, South Dakota	44° 04' 30" N 103° 12' 30" W	995	SP: 25,000 LP: 1,500	Shale overlaying sandstone
San Juan, Puerto Rico (SJG)	U.S. Coast and Geodetic Survey	U.S. Dept. of Commerce ESSA Coast and Geodetic Survey Rockville, Maryland 20852	18° 06' 42" N 66° 09' 00' W	457	SP: 50,000 LP: 750	Vaults are on units of flow and flow breccia, volcanic breccia, conglomerate, sandstone and siltstone.

(Continued)

LOCATION OF STATION	NAME OF OPERATING ORGANIZATION	ADDRESS OF OPERATING ORGANIZATION	STATION COORDINATES	STATION ELEVATION (Meters)	OPERATIONAL MAGNIFICATION (Vertical)*	GEOLOGICAL DESCRIPTION OF STATION FOUNDATION
South Pole, Antarctica (SPA)	U.S. Coast and Geodetic Survey	U.S. Dept. of Commerce ESSA Coast and Geodetic Survey Rockville, Maryland 20852	90°S 0°Longitude	2927	SP: 100,000 LP: 375	Ice cap 2700 meters thick
Spring Hill, Alabama (SHA)	Spring Hill College	Department of Physics Spring Hill College Mobile 22, Alabama	30° 41' 41" N 88° 08' 23" W	59	SP: 6,250 LP: 1,500	Sand gravel and clay of Citronelle formation underlain by clays and sands.
State College Penn. (SCP)	Pennsylvania State University	Geophysical Laboratory 207 Mineral Sciences Bldg. University Park, Penn.	40° 48' 36" N 77° 52' 10" W	353	SP: 50,000 LP: 3,000	Ordovician Stonehenge limestone.
Tucson, Arizona (TUC)	U.S. Coast and Geodetic Survey	U.S. Dept. of Commerce ESSA Coast and Geodetic Survey Rockville, Maryland 20852	32° 18' 35" N 110° 46' 56" W	986	SP: 200,000 LP: 3,000	Metamorphic bedrock.
Weston, Massachusetts (WES)	Weston College	Weston Observatory Weston 93, Massachusetts	42° 23' 5" N 71° 19' 20" W	60	SP: 50,000 LP: 3,000	Paleozoic metavolcanic bedrock

*As of January 1970. Magnifications are at 1 sec period for short period (SP) instruments and at 15 or 20 second period for long period (LP) instruments.

ATTACHMENT 1

Large Aperture Seismic Array (LASA)

1. Array Station Name - Large Aperture Seismic Array (LASA).

2. Location - The array is located in eastern Montana with a field maintenance centre at Miles City, Montana, and a data formatting and transmittal centre at Billings, Montana. The array is connected by 50-kilobit dedicated digital data link to the Seismic Array Analysis Center in Washington, D.C., where the data is collected and processed.

3. Operating Organization - Array is operated by a civilian contractor (currently the Philco-Ford Corporation) under the technical management of the Electronics Systems Division of the United States Air Force Systems Command. The array is a part of the VELA Program directed by the Advanced Research Projects Agency of the Department of Defense.

4. Array Configuration - The LASA has an over-all aperture of 200 kilometres and is composed of 21 subarrays arranged in superimposed circles as shown in figures 1 and 2. With the exception of subarray E3, which is 19 km in diameter, all subarrays are 7 km in diameter (figure 3). Subarray E3 contains 25 short period seismometers. All others contain 16 short period sensors. All subarrays except for B1, B2, B3, and B4 have 3-component long period seismographs installed at the centre of the subarray. The short period sensors are emplaced in boreholes at a depth of 200 feet. The long period instruments are in sub-surface vaults.

5. Array Operation - Data from each sensor is transmitted in analog form via buried cables to a central terminal vault in each subarray, where the signals are converted into digital form for transmission by telephone line and microwave telemetry to a data centre at Billings, Montana. The LASA data are reformatted at the Billings LASA Data Center (LDC) for on-line transmittal via 50-kilobit data link to the Seismic Array Analysis Center (SAAC) in Washington, D.C. The array is controlled and monitored from the Billings Data Center and the array data is recorded and processed at the SAAC.

6. Array Instrumentation -

a. Long Period - The LP system has a useful passband from below 0.05 Hz to about 0.2 Hz. The equipment at each subarray detects and conditions

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three components of earth motion: vertical, north-south, and east-west components. It includes seismometers, amplifiers, filters, and protection devices. Typical seismometer response is shown in figure 4. System response curves are shown in figures 5 and 6.

b. Short Period - The sensor used for the S.P. array is the Hall-Sears HS-10-1 (ARPA) seismometer.

The amplifier used with the short period system is the Texas Instrument RA-5 parametric amplifier.

Typical short period instrument system response is shown in figure 7.

7. Geologic Setting - The LASA subarrays are situated in an irregular, relatively shallow structural basin at the northern edge of the Powder River Basin (figure 8).

This portion of the Great Plains Province is primarily composed of continental incompetent sediments of Tertiary age. The fine-grained sands and silty shales are imbedded with clay, dirty coals, and lignitic layers. Infrequent intervals of impure sandy limestone are also found (figure 9).

The LASA is primarily located on sediments of the Tertiary, Fort Union Formation.

8. Array Co-ordinates and Elevations - The co-ordinates and elevations of the centres of the subarrays are given in figure 10.

9. Data Recording at the Seismic Array Analysis Center (SAAC) - All recording is on digital magnetic tapes, phase-encoded, 1,600 bpi, 9 track. A single reel, 63 minutes of tape, will contain LASA, ALPA, and some NORSAR data.

LASA Data - 369 short period seismometers at 10 Hz (including 6 special and 20 attenuated channels) and 51 long period components at 1 Hz. Each physical record contains 0.5 seconds of high rate (10 Hz) data with low rate data (1 Hz) submultiplexed over two records. Record also contains time, parity, and validity indicators, telemetry alarms, subarray and seisometer status. All data are recorded in 16 bit fields as 14 bit fixed point integers, two's complement form, with 2 validity indicator bits.

ALPA Data - 57 long period components at 1 Hz plus time, site and seismometer status, validity indicators, selected beams, and processing

parameters. Data values are recorded in 16 bit fields as 12 bit fixed point integers, two's complement form, each with a 4 bit binary gain code prefix.

In addition to this LASA-ALPA tape, a special low rate tape is made containing only the long period data. A 2,400 ft reel covers about 10 hours 48 minutes of data. For LASA each physical record contains 10 seconds low rate data plus selected long period beams; for ALPA each physical record contains 15 seconds of data.

Both of the data tapes described above may contain NORSAR data as well as LASA and ALPA data.

10. Timing - Time is recorded on tape at 0.1 second intervals using digital clock, WWV, and the VELA time code.

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Subarray Centre (Position 10) Locations and Elevations

Subarray	Latitude (N)			Longitude (W)			Surface Elevation
	°	'	"	°	'	"	m
A0	46	41	19	106	13	20	896.8
B1	46	45	08	106	05	30	906.8
B2	46	38	06	106	09	46	846.3
B3	46	39	33	106	19	01	874.9
B4	46	46	05	106	14	35	869.0
C1	46	50	22	106	07	39	870.4
C2	46	40	10	106	00	45	931.8
C3	46	34	27	106	14	59	834.8
C4	46	44	07	106	22	26	916.4
D1	46	50	23	105	53	22	911.0
D2	46	30	11	106	00	39	813.1
D3	46	32	59	106	28	49	952.9
D4	46	56	31	106	23	00	866.0
E1	47	09	46	106	03	22	837.9
E2	46	30	46	105	21	53	762.2
E3	46	08	58	106	20	03	913.7
E4	46	45	39	106	55	00	955.3
F1	47	22	15	105	11	15	892.5
F2	45	54	34	105	29	08	906.7
F3	45	58	22	107	04	54	989.7
F4	47	24	40	106	56	37	859.8

Figure 10.

ATTACHMENT 2

Alaskan Long-Period Array (ALPA)

1. Station Name. Alaskan Long-Period Array (ALPA).

2. Operating Agency. Headquarters, United States Air Force, Air Force Technical Applications Center, VELA Seismological Center, Alexandria, Virginia, 22313.

3. Co-ordinates and Elevations of Seismometer Sites. See table 1

4. Array Configuration and Geologic Setting. The ALPA consists of 19 seismometer sites arranged in a filled hexagonal pattern measuring 80 kilometres across with a nominal distance of 20 kilometres between adjacent sites (figure 1). The ALPA is located within the Yukon-Tanana uplands, a region of gently rolling topography underlain principally by moderately to slightly metamorphosed sediments which grade from interbedded pre-Cambrian quartzites and schists in the southern portion of the array to slightly recrystallized sandstone, slate, and siltstones of Paleozoic age in the north. Bedrock at the ALPA sites is overlain by a maximum of 5 to 10 feet of overburden.

5. Instrumentation.

a. General. Three long-period borehole seismometers, together with electronic equipment to filter, amplify, and digitize the seismic signals as well as to measure and adjust seismograph system operating parameters, are located at each of the 19 ALPA instrument sites. Operation of the array is controlled and monitored by a small computer housed in a centrally located monitor and maintenance centre. Data digitized at the instrument sites are telemetered to the monitor and maintenance centre where they are combined with time and array status information and transmitted continuously over a telephone circuit to the Seismic Array Analysis Center (SAAC) in Washington D.C. for recording and analysis. At the monitor and maintenance centre, all array data are also recorded on 9-track 800 bit per inch magnetic tape as backup for the transmission circuit to the SAAC, and on 16 mm film for instrumentation system monitoring. At the SAAC, incoming ALPA data are beam formed to provide world-wide coverage for body and surface waves. Selected beam outputs, together with signals from an individual site, are also continuously recorded on 16 mm film at the SAAC.

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Table 1

Map Location Data, 19-Site Alaskan Long-Period Array

Site Code	N. Latitude (±10 sec)	W. Longitude (±20 sec)	Elev. (±50 ft) feet	metres	Instr. Depth feet	metres
1-1	65° 14' 00"	147° 44' 36"	2,100	640	45	13.8
2-1	65° 22' 25"	147° 24' 04"	1,850	564	50	15.4
2-2	65° 11' 40"	147° 18' 58"	2,250	686	47	14.5
2-3	65° 03' 55"	147° 33' 50"	1,300	396	49	15.1
2-4	65° 05' 52"	148° 00' 05"	1,400	427	50	15.4
2-5	65° 16' 01"	148° 08' 11"	1,450	442	51	15.7
2-6	65° 24' 02"	147° 53' 57"	1,800	549	50	15.4
3-1	65° 30' 10"	147° 07' 03"	2,350	716	48	14.8
3-12	65° 20' 02"	147° 00' 27"	2,200	671	45	13.8
3-2	65° 08' 53"	146° 52' 45"	2,100	640	45	13.8
3-23	65° 01' 43"	147° 11' 46"	1,850	564	48	14.8
3-3	64° 54' 36"	147° 26' 47"	1,125	343	46	14.2
3-34	64° 56' 41"	147° 51' 34"	1,500	457	46	14.2
3-4	64° 57' 07"	148° 17' 03"	2,350	716	175	53.8
3-45	65° 07' 42"	148° 24' 05"	1,800	549	44	13.5
3-5	65° 18' 55"	148° 35' 10"	1,500	457	50	15.4
3-56	65° 26' 09"	148° 18' 56"	1,400	427	55	16.9
3-6	65° 33' 24"	148° 00' 00"	1,900	579	50	15.4
3-16	65° 32' 23"	147° 35' 31"	2,050	625	51	15.7

b. Seismometers. Three tilted-axis long-period borehole seismometers are located at each of the 19 array sites. The depth of installation is given in table 1. The sensitive axes of the three seismometers are oriented 35° 16' above the horizontal at azimuths of 60°, 180°, and 300° to provide three orthogonal components of motion.

c. Seismograph System. The relative displacement amplitude response for all ALPA seismographs is given in table 2 and plotted in figure 2. The seismometers are operated at a free period of 20^{+} .5 seconds with damping 1.67 times critical. Signals are digitized once per second and automatically gain ranged. The system has a digital resolution of 11 bits plus sign and an automatic scaling range of 60 dB in 6-dB steps for an over-all dynamic range of 120 dB. Each unprocessed ALPA digital data word consists of a sign bit, an 11-bit mantissa, and a 4-bit binary gain code.

d. Timing System. Timing is accurate to ±40 milliseconds with a maximum drift rate of one part in 10^{-8} per week.

e. Recording. Unprocessed ALPA seismic data, together with array time and instrument status information, are routinely recorded digitally on magnetic tape at the SAAC. Outputs from the on-line processing are also recorded on magnetic tape. Tape records and logs will be retained indefinitely. Data format and reformatting capabilities available at the SAAC are specified in the description of the Montana Large Aperture Seismic Array (LASA). The 16 mm develocorder film records of all seismometers in the array made at the monitor and maintenance centre and of beams formed at the SAAC are stored indefinitely. Copies of these film records can be made as required.

6. General. The ALPA is currently being installed with recording of the full array to begin during the last half of 1970. The ALPA is being operated on a developmental basis so that changes in system parameters and operating procedures, as well as occasional interruptions in data recording, may be expected from time to time.

Table 2

Displacement Frequency Response

Period (sec)	Normalized Amplitude	Percent Amplitude ± Tolerance
10	0.151	15
15	0.533	10
20	0.912	5
25	1.000	0
30	0.890	5
40	0.535	10
50	0.365	12.5
60	0.236	15
80	0.112	20
100	0.0657	25"

/The detailed information on the United States seismic stations; attached to the above communication, namely - frequency response of the World-Wide Standard Seismograph; map of Montana LASA; Montana LASA Subarray Geometry; LASA Subarray Configurations; typical Seismometer response; system frequency response curve (configuration A, B); Short period Instrument Response; Structure map, LASA; Eastern Montana; generalized section of the exposed rocks of south-east Montana; Location map of Alaskan long-period array; relative amplitude response - is deposited in the archives of the United Nations and interested delegations may consult them upon request to the Disarmament Affairs Division./
