HANDBOOK:
WORLD-WIDE STANDARD
SEISMOGRAPH NETWORK

April 1964

Acoustics and Seismics Laboratory
Institute of Science and Technology
THE UNIVERSITY OF MICHIGAN
Ann Arbor, Michigan
NOTICES

Authorship. This report was prepared by Tom Powell and Donald Fries.

OTS Availability. Requesters may obtain copies of the document from:
Office of Technical Services
Department of Commerce
Washington 25, D. C.

Final Disposition. After this document has served its purpose, it may be destroyed. Please do not return it to the Institute of Science and Technology.
CONTENTS

Notices .......................................................... iii
List of Stations .................................................. vii
Abstract .......................................................... 1
Introduction ....................................................... 1
Station Descriptions .............................................. following page 10
## LIST OF STATIONS

| AAE | Addis Ababa, Ethiopia          | LON | Longmire, Washington        |
| AAM | Ann Arbor, Michigan           | LPA | La Plata, Argentina         |
| ADE | Adelaide, Australia           | LPB | La Paz, Bolivia             |
| AFI | Afiamalu, Samoa               | LPS | La Palma, El Salvador       |
| ALQ | Albuquerque, New Mexico       | LUB | Lubbock, Texas              |
| ANP | Anpu, Taiwan                  | MAL | Malaga, Spain               |
| ANT | Antofagasta, Chile            | MAN | Manila, Philippines         |
| AQU | L'Aquila, Italy               | MDS | Madison, Wisconsin          |
| ARE | Arequipa, Peru                | MNN | Minneapolis, Minnesota      |
| ATH | Athens, Greece                | MUN | Mundaring, Australia        |
| BAG | Baguio, Philippines           | NHA | Nhatrang, South Viet-Nam    |
| BEC | Bermuda                       | NNA | Nana, Peru                  |
| BHP | Balboa Heights, Canal Zone    | NUR | Nurmijarvi, Finland         |
| BKS | Berkeley, California          | OGD | Ogdensburg, New Jersey      |
| BIR | Blacksburg, Virginia          | PDA | Ponta Delgada, Azores       |
| BOG | Bogotá, Colombia              | PMG | Port Moresby, New Guinea    |
| BUL | Bulawayo, Southern Rhodesia   | PRE | Pretoria, South Africa      |
| CAR | Caracas, Venezuela            | QUE | Quetta, Pakistan            |
| CCG | Camp Century, Greenland       | QUI | Quito, Ecuador              |
| CHG | Chiangmai, Thailand           | RAB | Rabaul, New Guinea          |
| COP | Copenhagen, Denmark           | RCD | Rapid City, South Dakota    |
| COR | Corvallis, Oregon             | RIV | Riverview, Australia        |
| CTA | Charters Towers, Australia    | SBA | Scott Base, Antarctica      |
| DAL | Dallas, Texas                 | SCP | State College, Pennsylvania |
| DUG | Dagway, Utah                  | SEO | Seoul, Korea                |
| FLO | Florissant, Missouri          | SHA | Spring Hill, Alabama        |
| GDH | Godhavn, Greenland            | SPA | South Pole, Antarctica      |
| GEO | Georgetown University         | STU | Stuttgart, Germany          |
| GOL | Golden, Colorado              | TAU | University of Tasmania      |
| GSC | Goldstone, California         | TOL | Toledo, Spain               |
| HLL | Hallett, Antarctica           | TRN | Trinidad, West Indies       |
| HLE | Helwan, Egypt                 | TUC | Tucson, Arizona             |
| HNR | Honiara, Guadalcanal          | UME | Umea, Sweden                |
| IST | Istanbul, Turkey              | VLN | Valentia, Ireland           |
| KEV | Kevo, Finland                 | WEL | Wellington, New Zealand     |
| KIP | Kipapa, Hawaii                | WES | Weston, Massachusetts       |
| KON | Kongsberg, Norway             | WIN | Windhoek, South Africa      |
| LAH | Lahore, Pakistan              |     |                             |

**Note:** Within this handbook stations are arranged alphabetically according to abbreviations.
HANDBOOK: WORLD-WIDE STANDARD SEISMOGRAPH NETWORK

ABSTRACT

This report is a compilation of information about each of the seventy-five stations in the World-Wide Cooperative Standard Seismograph Network as of June 1963. This information includes material on each station's location and facilities, environment, vault and pier construction, and instrumentation. Maps, diagrams, and photographs supplement the text.

1

INTRODUCTION

The handbook on the World-Wide Standard Seismograph Network is a compilation of information about each of the network's seventy-five stations in operation as of June 1963. This network was created under the sponsorship of participating scientific organizations including the United States Coast and Geodetic Survey. This information has been organized under four subject headings: (1) Station Facilities; (2) Station Environment; (3) Station and Pier Construction; and (4) Station Instrumentation. The stations are listed alphabetically.

Each station has been located geographically and described as thoroughly as possible, even in its relation to the local topography and nearby structures. Information about local geology, instrument magnifications, local background and noise, other instruments in operation, and research in progress has also been included. When available, maps, diagrams, and photographs have been used to supplement the text.

In some cases complete station information was unobtainable. However, since approximately fifty more stations will be added to the world-wide network, necessitating a revised handbook, more information can be added at that time.

The University of Michigan is grateful to the personnel of the United States Coast and Geodetic Survey for assistance in the preparation and review of material.
FREQUENCY RESPONSE OF THE LONG-PERIOD SYSTEM,
WORLD-WIDE STANDARD SEISMOGRAPH
FREQUENCY RESPONSE OF THE WORLD-WIDE STANDARD SEISMOGRAPH
FREQUENCY RESPONSE OF THE SHORT-PERIOD SYSTEM, WORLD-WIDE STANDARD SEISMOGRAPH
STATION FACILITIES

STATION: Addis Ababa, Ethiopia
STATION DIRECTOR:
Mr. Pierre Gouin

TELEPHONE NUMBER:
13175 (Ext. 25)

GEOGRAPHIC COORDINATES:
Latitude: 09° 01' 45" N
Longitude: 38° 45' 56" E

HISTORY OF STATION:
The observatory was founded and designed by its director, Mr. Pierre Gouin. Instruments of geomagnetics started operating in January, 1958. The seismology section began operation in March, 1959. World Array equipment began operating here on June 11, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
Local mountains around Addis Ababa are about five to seven km from the observatory and are 1000 to 1500 feet higher than the city. They form an arc of approximately 180° around the city in the direction of west to SE. The observatory is located within the city of Addis Ababa. There are no nearby rivers.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located on the campus of the University College of Addis Ababa. The nearest buildings, two-story university buildings, are about 150 feet from the station.

LOCAL GEOLOGY:
Addis Ababa is situated on the ill-defined western margin of the Main Ethiopian Rift where this begins to funnel out northwards into the Afar Depression. The bedrock of the Rift and plateau in this region is formed by the Tertiary Trap Series. The Series is composed chiefly of stratoid olivine basalts, such as the Addis Ababa geophysical observatory itself lies upon, and includes alkaline trachytes, silicic lavas, and pyroclasts. The Entotto range immediately north of Addis Ababa is composed of subsilicic lavas and tuffs upon the normal basalts. West of Addis Ababa lies the late Tertiary Volcanic mass of Wachacha, a carbonatitic
center. The basalts which floor Addis Ababa are estimated to be about 1000 meters thick and are underlain by Mesozoic sandstones, limestones, and gypsum. These underlying formations are downwarped and thickened under the Rift. These Mesozoic strata total 1200 meters and rest on basement complex parashists. Although a western horst to the Rift is not developed north of the Guraghe Mountains in the Addis Ababa region, minor faulting breaks the gentle gradient down to the Rift floor at Adama. Bishoftu, 45 km SE of Addis Ababa, is situated upon a line of clockwise wrench faulting. A marked minor fault runs about 15 km east of Addis Ababa, following the usual NNE-SSW Rift trend. The lower part of Addis Ababa is situated at the foot of the Entotto hills, upon the Filwoha fault, with which hot springs are associated. This fault is probably another wrench fault of the Bishoftu type. Commencing about 20 km west of Addis Ababa and extending westwards for another 100 km, the fresh Ambo fault shows a downthrow of 200 meters to the south.

STATION AND PIER CONSTRUCTION

PIERS:
The piers are made of reinforced concrete and extend down through a void space under the building of about 2 1/2 meters. They are attached to basalt. The piers are completely isolated from the floor or any other part of the building.

VAULT TEMPERATURE AND HUMIDITY:
The station has no heaters or air conditioners. Wide seasonal or daily fluctuations of temperature are not expected. Although it is true that there is much rain during certain months of the year, humidity is no problem; evaporation is so great at this altitude that the humidity is not noticeably increased.
GEOPHYSICAL OBSERVATORY, ADDIS ABABA, ETHIOPIA
STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 25000±
SP N-S: 25000±
SP E-W: 25000±
LP Z: 750±
LP N-S: 750±
LP E-W: 750±

The short-period horizontalss could operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 0.5 sec
AVERAGE AMPLITUDES: Not given.

REMARKS: There are no seasons in Ethiopia. Microseismic activity is greater at sunrise and sunset. There is less activity during the rainy months (July to September) because the sky is overcast. Active volcanoes are nearby; "Chubby," the nearest, is approximately 120 km from Addis Ababa. However, local earthquakes make it impossible to determine if this activity is recorded. Karakore, a village about 200 km north of Addis Ababa, has experienced about 5000 earthquakes since May, 1961. These quakes are recorded at the station, of course, with the apparent time difference between S and P of about 22 to 24 seconds. A major fault, Fitwoha, runs through Addis Ababa; earthquakes, not uncommon, are suspected to originate along this fault trace.

MAN-MADE NOISE:

FROM THE SEISMMETER VAULT:

The nearest railroad is 3 km
The nearest dam is 100 km
The nearest river is 50 km

REMARKS: The station is located in a reasonably quiet zone of the city. There is only very light traffic along the street about 100 feet east of the building. No heavy machinery operates anywhere near the installation site.

OTHER INSTRUMENTS IN OPERATION.

1. Willmore 3-component seismograph (period 1 sec)
2. Portable, quartz-spring gravimeter
3. Ruska variographs
4. Ruska earth inductor
5. Chasselon D-magnetometer
6. Meteorological instruments
TOPOGRAPHIC MAP OF ADDIS ABABA
Unless otherwise stated, dimensions are in cm.

Other buildings not indicated:
- Magnetic Bldgs: Absolute & Variation
- Power house

STATION, ADIS ABABA
RESEARCH PROJECTS IN PROGRESS:

(1) Geologic survey of the area
(2) Geomagnetic research
(3) Research on solar activity
STATION FACILITIES

STATION: Ann Arbor, Michigan

STATION DIRECTOR:
Dr. James T. Wilson

TELEPHONE NUMBER:
Area 313, NO 3-1511 (Ext. 3000)

STATION ABBREVIATION: AAM

MAILING ADDRESS:
c/o Dr. J. T. Wilson
Department of Geology
University of Michigan
Ann Arbor, Michigan

CABLE ADDRESS:
IST
Willow Run Airport
Ypsilanti, Michigan

ELEVATION: 249 meters

HISTORY OF STATION:
Dr. James T. Wilson has been director since 1940, when the seismological observatory was established at The University of Michigan. World Array equipment began operating here on October 22, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The University of Michigan World Array station is located approximately equidistant from the cities of Ann Arbor and Ypsilanti. It is 7.2 km NE of Ann Arbor and 7.2 km NW of Ypsilanti. The Huron River is 3.2 km to the south, and several small creeks are situated closer to the station, the nearest being about 0.4 km to the west. The surrounding region is moderately hilly. Highways and roads are close to the station. M-14, a blacktopped, well-traveled highway is 1.6 km north. Gale Road, a graveled road 0.4 km east, is only lightly traveled. Geddes Road, blacktopped, and used heavily during rush hours, is 2.6 km to the south. A modern, four-lane highway (US 23) is 2.4 km to the west.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located on the eastern edge of the Botanical Gardens of the university. There are no buildings or man-made structures in the immediate area. A gravel pit about 200 yards to the NE appears to be inactive. Another gravel pit is located 0.8 km to the NE. The only
activity consists of power shovel operations; there is no blasting. The few houses in the area are 0.4 km away. The nearest part of the campus is 3.2 km to the west.

LOCAL GEOLOGY:
The area in which the station is located has 200 feet of glacial drift (gravel) overlaying 800 feet of shale. The shale covers 4800 feet of limestone. Granite is found 5670 feet below the surface.
GEOLOGIC COLUMN
AT AAM SCIENCE STATION

Latitude - 42°17'
Longitude - 83°40'

DEPTH (ft)

-0
Glacial Drift

-200
Shale

-216
Shale with Sandstone

-530
Black Shale

-600
Limestone and Shale

-1010
Limestone

-1100
Dolomite Limestone

-1300
Halite, Anhydrite

Dolomite, Limestone, Shale

-5670
Halite, Anhydrite

Sandstone

Granite

(860' Above Sea Level)
STATION AND PIER CONSTRUCTION

PIERS:
See diagrams.

VAULT TEMPERATURE AND HUMIDITY:
There is no environmental control in the seismometer vault. A wall heater, thermostatically controlled, is in the console room. There is also a small wall heater in the recording room. Little daily or seasonal temperature fluctuation is expected, because the seismometer vault and recording room are both underground. The console room is well insulated.

The console room also has no humidity problem. The recording room has some humidity, but it is hoped that the wall heater and a dehumidifier will dry it up. Humidity is present in the seismometer vault, but a shed over the top, where moisture can escape, should take care of this. Silica gel may absorb some of it. Since both the recording room and seismometer vault are underground, humidity will probably be higher during the wet seasons (autumn and spring).

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 25000
SP N-S: 25000
SP E-W: 25000
LP Z: 1500
LP N-S: 1500
LP E-W: 1500

None of these systems could operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 0.5 sec

AVERAGE AMPLITUDES: 0.08 μ

REMARKS: The greatest microseismic activity is usually during the winter months, November through March. It drops off during the summer. It seems logical that the biggest part of microseismic activity is due to the proximity of the Great Lakes. The rest of the natural microseismic activity would be caused by regional winds and nearby streams and rivers. Natural seismic disturbances would stem from the proximity of the Great Lakes, particularly Lake Huron and Lake Michigan. In addition, the Huron River is quite close to the station, as are many streams and small lakes.
MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:
The nearest railroad is 3.2 km
The nearest highway is 1.2 km
The nearest dam is 4 km
The nearest river is 3.2 km

REMARKS: Since the station is very close to highways, roads, and railroads, this is not a low background station.

OTHER INSTRUMENTS IN OPERATION:
The other instrument operating near the World Array installation, and operated by the Institute of Science and Technology personnel, consists of an 8-inch cased dry hole approximately 1275 feet deep with a 69-foot concrete plug in the bottom. The upper 250 feet of the hole is set with a surface string of 12-inch casing.

The package on the bottom consists of a brass cylinder containing three Hall-Sears model HS-10, 2-cycle vertical seismometers, two of which are of high impedance (200,000 ohms); the other is a medium impedance unit (4000 ohms). On perpendicular axis are two Hall-Sears model HS-10, 2-cycle horizontal units. These are both of medium impedance (4000 ohms). This package is approximately 4 feet long and 7 inches in diameter.

The cable from this package is brought up the hole and distributed into as many as 6 amplifiers, each of which has a possible gain of 90 db. These amplifiers are each connected to an individual FM recording channel on an Ampex model FR-1100, 1/2" magnetic tape recorder. Simultaneous voice comments and WWV are directly recorded on Channel #7. Full recording level on all channels is 1 volt rms. This equipment is not operated continuously, but only during special projects.

RESEARCH PROJECT IN PROGRESS:

<table>
<thead>
<tr>
<th>SPONSOR</th>
<th>TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF Cambridge</td>
<td>Seismic Study &amp; Experimental Investigation</td>
</tr>
<tr>
<td>AFTAC</td>
<td>Seismic Wave Propagation</td>
</tr>
<tr>
<td>AF Office Scientific Research</td>
<td>Auditory Recognition</td>
</tr>
<tr>
<td>AF Office Scientific Research</td>
<td>Seismic Data Analysis Research</td>
</tr>
<tr>
<td>AF Systems Command</td>
<td>Studies of Earthquakes in Foreign Countries</td>
</tr>
<tr>
<td>AF Systems Command</td>
<td>Seismic Background Noise</td>
</tr>
</tbody>
</table>
STATION FACILITIES

STATION: Adelaide, Australia
STATION DIRECTOR:
   Dr. D. J. Sutton
TELEPHONE NUMBER:
   Office W3211 (Ext. 316)
   University of Adelaide
   ADELAIDE, South Australia
GEOGRAPHIC COORDINATES:
   Latitude: 34° 58' 01" S
   Longitude: 138° 42' 32" E
CABLE ADDRESS:
   UNIPHYSICS ADELAIDE
ELEVATION: 645 meters

STATION ABBREVIATION: ADE
MAILING ADDRESS:
   Dr. D. J. Sutton
   Physics Department

HISTORY OF STATION:
The station at Mt. Bonython began operating in June, 1958. Dr. D. J. Sutton has always been the director. World Array equipment began operating here on May 24, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is 11.2 km from the city and is located on the side of a hill (Mt. Bonython) which is well covered with trees. However, within 100 feet of the vault trees have been removed. Mt. Bonython is part of the Mt. Lofty ranges whose highest peak, Mt. Lofty, is 2300 feet high. There are no major rivers within 80 km.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
   There is a 100-foot tower 200 yards from the vault; its height will be increased to 200 feet within the next twelve months. At Mt. Lofty, 0.8 km away, there are three 500-foot television towers. The nearest highway carrying heavy traffic is approximately 3.2 km away.

LOCAL GEOLOGY:
The sediments comprising the Mt. Lofty ranges are Precambrian geosynclinal deposits. In late Proterozoic, early Cambrian time these deposits were subjected to extensive folding and an ancient mountain range was formed. Peneplanation of this range occurred during the Paleozoic. In Tertiary time block faulting occurred along several planes, causing a rejuvenation of the landscape and the formation of the present Mt. Lofty ranges. Small movements still occur along these fault planes. Mt. Bonython is situated in the central block of the fault systems and is a predominant feature mainly because it consists of a quartzitic sandstone which has been resistant to weathering.
STATION AND PIER CONSTRUCTION

PIERS:

The seismometer vault consists of four rooms in one building. The building lies on bedrock, making the entire building the pier. The seismometer and galvo piers are separated from the floor of the vault; they are constructed of reinforced concrete and are attached to a Proterozoic sandstone of the Torreasion series. The sandstone (Aldgate sandstone) alternates with slate with minor conglomerate and heavy mineral laminations. The section varies in thickness from 1000 to 3000 feet. This is a section of undifferentiated metamorphism.

VAULT TEMPERATURE AND HUMIDITY:

The two dehumidifiers in the seismometer vault are not in operation because there has been no need for them. Humidity problems were not encountered during the installation of this station, and wide seasonal fluctuations are not expected. Both dehumidifiers are portable. One is in the short-period seismometer room, the other in the recording room.

Wide daily or seasonal temperature fluctuations are not expected. In 1961 the high temperature in the vault was during January (75°F). The low occurred in July (55°F).
(a) Long-Period Pier

(b) Short-Period Pier

CROSS SECTION OF PIERS

4′
STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 25000
SP N-S: 25000
SP E-W: 25000
LP Z: 750
LP N-S: 750
LP E-W: 750

SP N-S and Z could possibly operate 6 db higher in the summer.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 6 to 7 sec

AVERAGE AMPLITUDES: 3 μ

REMARKS: There are seasonal amplitude fluctuations. The greatest microseismic activity is during the winter months (i.e., May through August). The long-period microseisms have a period of from 6 to 7 sec. The 1-second period microseisms visible on the short-period records are associated with bad weather approaching from the SW. Local earthquakes are quite frequent, but no long-period waves are recorded from these quakes.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is approximately 8.8 km
The nearest highway is approximately 3.2 km
The nearest dam is approximately 12 km
The nearest stream is approximately 3.2 km

REMARKS: There are several rock quarries operating in the area. The periods of these blasts are around 0.5 sec, and propagation is usually less than 30 sec. They have been noted many times on test records.

OTHER INSTRUMENTS IN OPERATION: None

RESEARCH PROJECTS IN PROGRESS: None
STATION FACILITIES

STATION: Afi'amalu, Samoa
STATION ABBREVIATION: AFI

STATION DIRECTOR:
Mr. P. J. Milne

MAILING ADDRESS:
Observer in Charge
Apia Observatory
P. O. Box 52
Apia
Western Samoa

TELEPHONE NUMBER:
220 (2 rings)

CABLE ADDRESS:
Weather
Apia
Western Samoa

GEOGRAPHIC COORDINATES:
Latitude: 13° 54' 33.6" S
Longitude: 171° 46' 38.1" W

ELEVATION: 705.6 meters

HISTORY OF STATION:

The Apia Observatory was first established under the auspices of a scientific society in Goettingen, Germany, late in the nineteenth century. Seismic instruments (Wiecherts) were set up in 1902, and magnetic variometers and magnetic absolute instruments in 1905. A Wood-Anderson Torsion seismometer was installed in the 1930's, and Benioff (variable reluctance, Z and N-S) instruments in 1957. The Afi'amalu seismograph station of the Apia Observatory was first in operation in 1957, and was expanded for the standardized installation in 1962. Dr. C. Angenehister was the first and only director under Germany. New Zealand took over in 1914. Dr. E. Marsden was the first New Zealand director. After Dr. E. Marsden, the station directors were as follows:

Andrew Thomson 1915-1930
J. Wadsworth 1930-1938
B. Sapsford 1938-1945
J. W. Beagley 1945-1946

In 1946 the Apia Obersvatory became a sub-observatory under the Geophysical Observatory, Christchurch, New Zealand; under this arrangement directors assumed the title of Observer in Charge. In 1950 Apia Observatory came under the control of the New Zealand Geophysics Division in Wellington, an arrangement which still exists. Observers in Charge under this system were as follows:

A. G. Stanbury 1949-1951
P. Gill 1951-1953
A. Burrows  1953-1955
T. Thompson  1955-1957
J. G. Keys  1957-1962
P. J. Milne  1962-

World Array equipment began operating here on November 1, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is located slightly north of the center of the island of Upolu. This location is on the high central ridge of the island, although there are higher places, principally volcanic cones nearby. 1.6 km east of the station the topography is more rugged because of a northward draining river system. The Pacific Ocean is 9.6 km north and 11.2 km south.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is isolated, 9.6 km south of the city of Apia. The local radio station's transmitter tower (approximately 150 feet high) is about 300 feet north of the seismometer vault. The transmitter building is a fairly large one-story house approximately 200 feet east of the seismometer vault. The road passes about 300 feet SE of the seismometer vault, ends about 1.6 km beyond the station, and has very little traffic, most of which turns off at the radio transmitter or before.

LOCAL GEOLOGY:
The station is located on Middle and Late Pleistocene Volcanics (Salani). These are composed of basalt with canyons and deep soils, and cover wide reefs along the coast. The section is believed to consist of similar volcanics built up from the original ocean floor.

AFI-2
TOPOGRAPHY OF A SECTION OF UPOLU,
WESTERN SAMOA
STATION AND PIER CONSTRUCTION

PIERS:

The piers are constructed of reinforced concrete. The seismometer vault is below ground level, in what is equivalent to a basement. The floor is concrete, poured into an excavation in the basalt bedrock. The part above ground up to, but not including, the roof is covered with fill. The piers are not isolated from the vault floor; therefore, the entire vault floor is effectively one pier. The SP piers were original piers, and the LP pier was the original recording pier which has been modified and partially rebuilt. A new building was constructed 200 feet SW of the seismometers to house the console and recording equipment. Because this building is on loose fill rather than bedrock, the galvanometer (but not recorder) pier is isolated from the vault floor by a two-inch air gap. This pier extends about 5 feet below the recording room floor to the bedrock.

VAULT TEMPERATURE AND HUMIDITY:

Three 100-watt bulbs near the ceiling are constantly left on in the seismometer vault to reduce humidity. They are expected to be effective in stratifying the air in the vault. Leaves were placed on top of the seismometer vault roof and appeared to be somewhat successful in reducing noise on the LP horizontal seismometers. Because the seismometer vault is largely underground and climate conditions are relatively uniform, further environmental control is not necessary.

Wide temperature fluctuations are not expected. Outdoor temperatures are expected to remain well within the limits of 64°F and 84°F. The maximum variation could occur almost any time of the year between a cool rainy night and a hot sunny day, but in any of the vaults the temperature variation should be well within 5°F. In the seismometer vault between October 18 and 24 the maximum temperature was 80.5°F, and the minimum was 70.9°F. The coolest months are May and June, and the warmest are December and January.

Humidity is high enough so that paper expansion during recording is a problem. No other problems are expected at the recorders, console, or seismometers. October through March is the rainy season, and April through September is the dry season. Little difference is expected since outside humidity is constantly high. Because the vaults are well drained and dry, humidity is maintained at a constant and slightly lower level.
PROPOSED RECORDING BUILDING, AFIAMALU

Switch

Light
STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 12500  
SP N-S: 12500  
SP E-W: 12500  
LP Z: 750  
LP N-S: 750  
LP E-W: 750  
The LP systems could possibly operate at increased magnification during times of decreased microseismic activity.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 1 and 5 sec (during heavy seas: 8 sec)

AVERAGE AMPLITUDES: 0.15 $\mu$ (0 to peak) during heavy seas: 5.0 $\mu$ (0 to peak)

3.0 $\mu$ (0 to peak)

REMARKS: Microseismic activity fluctuations are not conspicuously seasonal. Microseismic activity fluctuations appear to be dependent on regional weather conditions. Local earthquakes from the Tonga-Kermadeo Trench on the Pacific Ocean floor, approximately 160 km SW of Samoa, are recorded at a rate of about 80 shocks per month. Wave action noticeably shakes buildings in Apia during heavy seas, and at these times the 8-sec microseisms are very conspicuous on the LP records. They have amplitudes of up to 10.0 $\mu$ (0 to peak).

MAN-MADE NOISE:

FROM THE SEISMOmeter VAULT:

It is 9.6 km to Apia's main street, which has typical small town traffic

The nearest dam is 4.8 km

The nearest river is 1.6 km (Pacific Ocean is 9.6 km away)

REMARKS: Other sources of noise are relatively negligible relative to natural background noise level. The shaking of buildings in Apia, discussed under natural disturbances (wave action), might be expected to be the greatest source of man-made noise, but any noise from these sources is concealed by the natural background. The radio transmitter tower is a possible source of noise which is also negligible in relation to the natural background noises.

OTHER INSTRUMENTS IN OPERATION:

(1) LaCour magnetic variometers
(2) Magnetometers, magnetic balance, earth inductor, and declinometer
(3) Meteorological instruments
(4) A Wood-Anderson seismograph

RESEARCH PROJECTS IN PROGRESS:
(1) Increased participation in the Seismic Sea Wave Warning System.
(2) Magnetic, photometric, and optical studies of artificial auroral displays following high altitude nuclear explosions.
STATION FACILITIES

STATION: Albuquerque, New Mexico
STATION DIRECTOR:
Mr. H. J. Wirz
TELEPHONE NUMBER:
Al 6-4411 (Ext. 22116)

STATION ABBREVIATION: ALQ
MAILING ADDRESS
U.S.C. & G.S. Seismological Laboratory
Sandia Base
Albuquerque, New Mexico
CABLE ADDRESS: Same as mailing address
ELEVATION: 1824 meters

GEOGRAPHIC COORDINATES:
Latitude: 34° 56’ 30” N
Longitude: 106° 27’ 30” W


STATION ENVIRONMENT

LOCAL GEOGRAPHY: Not given

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The seismometer vaults are 0.4 km south of other laboratory buildings. Other centers of activity are 3.2 or 4.8 km from the laboratory and do not normally include "noisy" operations at the present time. However, high explosive test shots have occasionally been detonated approximately 1.6 km north of the laboratory.

LOCAL GEOLOGY:
The region consists of basin and range block faulting with the downthrown blocks predominantly to the west. The blocks are bounded by northward and northeastward-trending normal faults. The stratigraphic section is made up of Pennsylvanian and later sediments, mostly limestone, resting on a peneplaned Precambrian complex of metasediments and granitic intrusives. The seismometers have been emplaced in an underground vault in one of the granites. The granite itself is characterized by lineation and shear fractures; no large continuous blocks exist because of the faulting.¹

STATION AND PIER CONSTRUCTION

The vault is in granite and has a concrete floor up to 4 feet deep in places. Piers are not used; this allows for versatile use of vault space. The cables are passed from room to room in a 4-inch box conduit. The calibration, lights, time, and radio time circuits also utilize conduit with outlet boxes; these circuits also go through a control panel at the vault entrance. The controlled a-c for the recorder motors is installed in a conduit run directly from the console.

VAULT TEMPERATURE AND HUMIDITY:

The vaults have an inherent temperature of \(14^{\circ}\)C. Thermostatically controlled heat is available, but because of the vault's constant temperature condition, a thermostat actuating is considered likely to produce more undesirable effects than desirable ones.

Seasonal or daily temperature fluctuations are expected to be extremely small and should occur only while work is being done in the vault.

Conditions in the vault are humid enough for untreated tools to rust readily. Outside humidity is generally low throughout the year. In addition, August is rainy, but the effects of this are not noticeable from the vault.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>The LP systems could operate at increased magnification under quiet weather conditions only.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>400000</td>
<td></td>
</tr>
<tr>
<td>SP N-S</td>
<td>400000</td>
<td></td>
</tr>
<tr>
<td>SP E-W</td>
<td>400000</td>
<td></td>
</tr>
<tr>
<td>LP Z</td>
<td>3000</td>
<td></td>
</tr>
<tr>
<td>LP N-S</td>
<td>3000</td>
<td></td>
</tr>
<tr>
<td>LP E-W</td>
<td>3000</td>
<td></td>
</tr>
</tbody>
</table>

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 1 sec

AVERAGE AMPLITUDES: 1.1 \(\mu\) (peak to peak based on LP response curves)

REMARKS: Microseismic activity is apparently greatest in the winter months during frontal activity. The station is new, and its history of microseismic activity is not extensive. A 0.5-sec period seismic energy is associated with the Mississippi Valley. The station is remote from most other natural seismic disturbances, but is apparently near some small local earthquake activity.
MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 19.2 km (8 km to a little used spur)
The nearest highway is 17.6 km (U.S. 66)
The nearest dam is 136 km (SSW) to Elephant Butte Reservoir
The nearest river is 19.2 km (Rio Grande)

REMARKS: Downtown Albuquerque is 24 km NW of the vault. Sandia Base about 16 km away, has fairly heavy traffic. Jets from Kirtland AFB are noticeable. The only significant noises are the high-explosive test shots detonated approximately 1.6 km north of the laboratory. The last series of shots was completed before this station was installed, but possible future shots would be expected to be a source of noise.

OTHER INSTRUMENTS IN OPERATION: See "Research Projects in Progress."

RESEARCH PROJECTS IN PROGRESS:

Computations about the Wilson-Lamison vertical were made. Different combinations of seismometers and galvanometers are being tried for different response curves and recorded through the USC & GS visible recorder. The long-period system of Cal. Tech. is recording in the vault. Another type of long-period instrument is being installed by Sandia Corporation. A shake table is being set up in the laboratory, and more research along this line is planned.
STATION FACILITIES

STATION: Anpu, Taiwan (Formosa)  
STATION ABBREVIATION: ANP  
STATION DIRECTOR:  
Mr. Kenneth T. C. Cheng  
MAILING ADDRESS:  
Taiwan Provincial Weather Bureau  
64 Kung Yuen Road  
Taipei, Taiwan, China  
TELEPHONE NUMBER:  
24141, 24142  
CABLE ADDRESS:  
METTAI  
GEOGRAPHIC COORDINATES:  
Latitude: 25° 11' N  
Longitude: 121° 31' E  
ELEVATION: 836 meters  
HISTORY OF STATION:  
This is a new station. World Array equipment began operating on March 14, 1963.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:  
The station is located in the saddle between two mountains. See topographic map.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:  
The station is isolated. No large or tall man-made structures are nearby.

LOCAL GEOLGY:  
The mountains around the station consist of andesite lava flows. The station rests on weathered Pleistocene andesite lava flows. This is possibly talus from the mountains.

STATION AND PIER CONSTRUCTION

PIERS:  
Piers are sunk about four meters and rest on weathered andesite lava flows of Pleistocene age. The tops of the piers are about 1 1/2 feet above the level of the vault floor. All piers are isolated. The vault itself has been excavated in the side of a hill.
VAULT TEMPERATURE AND HUMIDITY:
Environmental control consists of one dehumidifier in the SP seismometer vault and two
dehumidifiers in the recording room. No temperature or humidity fluctuations are expected.
The average relative humidity for every month of the year is 80%. In the vault, humidity is
regulated at 50% to 60%. In the recording room the humidity is 85%.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:
SP Z: 6250
SP N-S: 6250
SP E-W: 6250
LP Z: 750
LP N-S: 750
LP E-W: 750

None of the systems can operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 1, 1.5, 3, 60, 90 sec
AVERAGE AMPLITUDES: 0.3, 0.7, and 10 μ

REMARKS: Little is now known about microseisms. There are many local earthquakes.
Fumaroles and hot springs, which indicate dying volcanic activity, exist 2 km from the station.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:
The nearest railroad is 5 1/2 km
The nearest highway is 100 meters (unpaved)
The nearest river is 8 km

REMARKS: A new road is being built about 4 km away; periodic blasting is done.

OTHER INSTRUMENTS IN OPERATION:
None

RESEARCH PROJECTS IN PROGRESS:
Some case studies are being conducted.
STATION FACILITIES

STATION: Antofagasta, Chile

STATION DIRECTOR:
Senor Raul Bitran

TELEPHONE NUMBER:
92072 - Santiago

STATION ABBREVIATION: ANT

MAILING ADDRESS:
Instituto de Geofisica y Sismologia
Universidad de Chile
Casilla 2777
Santiago, Chile

CABLE ADDRESS:
Seismochile
Santiago, Chile

ELEVATION:
Approximately 80 meters. A survey has not been made. The elevation was estimated from topographic map.

GEOGRAPHIC COORDINATES:
Latitude: 23° 41' 56" S
Longitude: 70° 24' 54" W

HISTORY OF STATION:
The old station was installed in 1948 with Father Saa in charge. The station has two strong motion, mechanical amplification instruments made by the University of Chile which record on smoked paper.

In 1959 the station began a seismicity program using DTM Carnegie Institute instruments (W-L, vertical, operated through a transistor amplifier, ink recording, T_o = 1 sec and penmotor Tm = 0.1 sec) at Antofagasta and four surrounding stations. At the same time one Sprengnether L\(L^2\)-Z seismometer was installed, but its use was discontinued when the station was moved to its present location in April 1962. World Array equipment began operating on December 28, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is approximately 850 meters east of the Pacific Ocean with an elevation of approximately 80 meters. Seven km east of the station the elevation attains about 950 meters. The station is located about 5 km south of Antofagasta.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located on a hill about 500 meters east of the station's administration, research, and interpretation center which consists of two one-story buildings; otherwise it is
well isolated. There are two highways, one 450 meters north and the other 750 meters west of the station; neither carries much traffic. A railroad is 1100 meters northeast of the station.

LOCAL GEOLOGY:

See geologic map.
GEOLOGIC MAP OF ANTOFAGASTA AREA

- Terrace Sediments with Marine Fossils
- Alluvial Deposits
- La Negra Formation
- Way Formation
- Reddish Volcanic Porphyries with Intercaluciones of Elastic Continental Sediments
- Quartz, Clay and Calcite, Marine Fossiliferous Rock
STATION AND PIER CONSTRUCTION

PIERS:

The seismometer vault is 140 meters east of the recording and the console room. The galvanometer pier is made of concrete bonded to bedrock (limestone) approximately two feet below the concrete floor. The recorder pier is made of brick masonry built on the concrete floor. The seismometer piers are made of concrete bonded to the bedrock (limestone). The seismometer and galvanometer piers are isolated from the concrete floor by about 2", and the isolation space is filled with a "hard" tar-like material.

VAULT TEMPERATURE AND HUMIDITY:

There is no environmental control present.

Console Room: 22°C to 27°C
  Coolest from 0300 to 0800 hours.
  Warmest from 1300 to 1800 hours.

Recording Room: 20°C to 26°C
  Coolest from 0300 to 0800 hours.
  Warmest from 1300 to 1800 hours.

Seismometer Vault: 24°C to 26°C
  Very little variation in seismometer vault.

The above temperatures were recorded in December, 1962. During the cooler months (May to September) one can probably expect a temperature variation in the recording room from 8°C to 12°C throughout an entire day. The seismometer vault will vary much less. The instrument rooms are dry and will probably remain dry.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 50000
SP N-S: 50000
SP E-W: 50000
LP Z: 3000
LP N-S: 3000
LP E-W: 3000

The LP systems could possibly operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 6.0 sec
AVERAGE AMPLITUDES: Not known

REMARKS: The greatest amplitude fluctuation is expected from May to September; the least from November to February. There are numerous local earthquakes, and microseismic activity is high since the station is near the Pacific Ocean.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:
The nearest railroad is 1.1 km
The nearest highway is 0.45 km
The nearest dam is 300 km
The nearest river is 500 km

REMARKS: There are one or two mines approximately 10 km away in which occasional blasting is done. The Anaconda copper mine at Chuquicamata is about 220 km NE of the Antofagasta station. The station normally knows Chuquicamata's time of blasting and is using this data in a velocity research project. The highways have very little heavy traffic. The railroad has one or two trains daily.

OTHER INSTRUMENTS IN OPERATION:
(1) Two strong-motion, mechanical amplification seismometers made by the University of Chile. Recording is on smoked paper, periods are 12 and 7 sec.
(2) One Wilson-Lamison seismometer. Recording is photographic, T0 is 1 sec.
(3) One Montana type accelerograph
(4) One Carnegie DTM seismograph with a period of 1 sec.

RESEARCH PROJECTS IN PROGRESS:
(1) Local seismicity project
   (a) Fault plane solution
   (b) Velocity determination (Chuquicamata blasting is an aid in this study)
   (c) Crustal studies
   (d) Studying one earthquake that occurred on August 3, 1962
(2) Computer program for locating epicenters
STATION FACILITIES

STATION: L'Aquila, Italy

STATION DIRECTOR:
Prof. E. Villante

TELEPHONE NUMBER:
5960

STATION ABBREVIATION: AQU

MAILING ADDRESS:
Osservatorio Geofisico
Presso Castello
L'Aquila, Italy

CABLE ADDRESS:
Osservatorio Geofisico
Presso Castello
L'Aquila, Italy

ELEVATION: 721 meters

GEOGRAPHIC COORDINATES:
Latitude: 42° 21' N
Longitude: 13° 25' E

HISTORY OF STATION:
The station was begun by the National Geophysical Institute in 1952. Prof. Villante has always been the director. World Array equipment began operating here on May 11, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY: Not given

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station occupies three rooms in a castle located in the NE corner of the city. These rooms are approximately 30 feet below the ground level. In addition to the station, the castle houses a museum, auditorium, and living quarters for maintenance people.

LOCAL GEOLOGY:
The station is located on stratified limestone of unknown thickness. The formation is known to overlay granite. From reflections recorded at the station, Prof. Villante has computed that basalt begins about 18 km below the surface.

STATION AND PIER CONSTRUCTION

PIERS:
The concrete piers are embedded three meters into limestone. They are isolated from the castle and room floor by air.

VAULT TEMPERATURE AND HUMIDITY:
There is no environmental control present. Temperature in all rooms is quite constant. Variations are limited to 1°C or 2°C. Humidity is high throughout the entire year with little fluctuation.
STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 100,000  Both the LP Z and SP Z components could operate at increased magnification.
SP N-S: 100,000
SP E-W: 100,000
LP Z: 3000
LP N-S: 3000
LP E-W: 3000

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 3-6 sec

AVERAGE AMPLITUDES: Variable

REMARKS: The highest microseismic activity is in winter and spring. The microseism level is highest during periods of low barometer, high wind, and unsettled weather. Existing instruments operate at a gain level beneath the microseisms; hence definite conclusions cannot be drawn. L'Aquila is located in the Appenine Arc. Local events are frequently recorded. The Appenines also contain several active volcanoes; hence seismic activity from this source can be expected.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 1.6 km
The nearest highway is 0.45 km
The nearest river is 1.6 km

REMARKS: Man-made noise consists of that originating from the normal workday in the castle and city. Except possibly for the SP horizontals ($\approx 10 \times 10^3$) it does not limit instrument magnification.

OTHER INSTRUMENTS IN OPERATION: See "Research Projects in Progress."

RESEARCH PROJECTS IN PROGRESS:

Operation of an experimental LP seismograph.
STAION FACILITIES

STATION: Arequipa, Peru

STATION DIRECTOR:
Dr. Anibal Rodrigues Begazo

TELEPHONE NUMBER:
4038

STATION ABBREVIATION: ARE

MAILING ADDRESS:
Universidad Nacional de San Agustin
Instituto Geofísico
Casilla 23
Arequipa, Peru

CABLE ADDRESS:
SAOCAM via Smithsonian
Astrophysical Observatory
Cambridge, Mass.
c/o Arequipa Satellite Tracking Station

ELEVATION: 2451.6 meters

GEOGRAPHIC COORDINATES:
Latitude: 16° 27' 43.5” S
Longitude: 71° 29' 28.6” W

HISTORY OF STATION:
The Instituto Geofísico of the University of San Agustin began operations in March, 1959. The first seismograph was a Carnegie DTM. The present station was completed in February, 1960. World Array equipment began operating here on March 23, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is located 25.6 km SE of the City of Arequipa, near the town of Characato, which is 1.0 km SE. The very small village of Sabandia is NW 0.8 km. The volcano "El Misti" is 32 km NNE. In addition to the Chile River at Arequipa, the Sabandia River is 4.8 km SE of the station, and is most full from August to November. A dry gulch is located 0.8 km east of the station, but has water only rarely. A small irrigation ditch 200 feet west of the station has water intermittently.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The Smithsonian Satellite Tracking Station is adjacent to the north side of the seismograph station. Both stations are isolated from other centers of activity. Some very small farm buildings are nearby. A radio antenna is 90 feet NW of the vault.
LOCAL GEOLOGY:

The area immediately surrounding the seismograph installation at Characato is almost completely covered by various forms of volcanic material. As a consequence, only a few outcrops are present to indicate the section. The regional geology has been described by W. F. Jenks. A weathered agglomerate only a few meters thick forms the surface layer. The seismograph piers are set upon unweathered agglomerate composed of several types of volcanic rocks inclosed in a hard matrix of ash and welded tuff. Beneath the agglomerate is a series of basic volcanic flows and debris which make up the Chachani formation. At a depth of about 80 meters, the basement of plutonic and high grade metamorphic rocks is present.

At present the Arequipa region is one of high seismicity; generally, the intensity is quite small. The majority of the local shocks originate in the San Agustin fault, a major structural feature slightly east of the coastal mountains. A few very slight shocks seem to be associated with the volcano El Misti. Possibly they represent the compaction of collapse of the ash and tuff.

STATION AND PIER CONSTRUCTION

PIERS:

The piers are constructed of reinforced concrete. The soft, weathered agglomerate has been removed and the piers rest on hard agglomerate 5.7 meters below the vault floor level. The piers are wider at the bottom, the sides sloping at approximately 60°. The vault floors are separated from the piers by a 5-cm air gap. Below, the piers are separated from the surrounding soft rock by a variable gap approximately 30 cm to the forms; this is filled with sawdust to approximately 20 cm below the floor level.

VAULT TEMPERATURE AND HUMIDITY:

There is no environmental control present, as daily temperature variations are very slight. During the summer month of January temperature variations in the vault are from 25°C to 26°C. During the winter month of July the daily temperature fluctuations are expected to vary slightly more (between 22°C and 27°C). The vault is fairly lacking in humidity. The climate is arid, with the rainy season in February. From June through September there is practically no rain.
Concrete Pier, 5.7 m high, surrounded by sawdust

Weathered Agglomerate, soft matrix

Agglomerate volcanic debris in a hard matrix of welded tuff, Quaternary mud flow

Lava Flows, Chachani volcanos, Tertiary and Quaternary

Basement, gneiss, migmatite, pegmatite, and large bodies of diorite and granodiorite.

CHARACATO SEISMOGRAPH STATION
(Estimated Section)
STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 50000
SP N-S: 50000
SP E-W: 50200
LP Z: 2950
LP N-S: 3000
LP E-W: 2950

The SP Z could operate at increased magnification. This is limited by the specification that gain be the same as the rest of SP system.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 6 sec

AVERAGE AMPLITUDES: 0.5 to 1.0 μ (0 to peak based on LP response curves).

REMARKS: Microseismic activity is greatest during the winter months of June and July and generally least during the summer. Microseismic activity was investigated in the past by means of the Wilson-Lamison seismograph system, a system not considered to have the best response for such studies. The periods ranged from 1.7 to 2.5 seconds, with an average of 1.8 seconds. The maximum amplitude was 0.1 μ, 0 to peak. These are considered to be associated with atmospheric changes and wind. Micro-tremors are associated with the volcano El Misti. Local earthquake activity is very high, with occurrences every day, although only a few shocks per month can be felt. Other disturbances such as wave action are unimportant. Continuous background noise is present on the short-period records, but is not as pronounced on the horizontals as the vertical. This has a frequency of approximately 3 cps.

MAN-MADE NOISE:

FROM THE SEISMOmeter VAULT:

The nearest railroad is 16 km
The nearest highway is 16 km
The nearest dam is 47 km
The nearest river is 5 km (Sabandia River—appreciable amount of water only from August to November)
The Pacific Ocean is 140 km

REMARKS: Although the Carnegie DTM seismograph system is sensitive to trucks going by on the road, the standardized seismograph system does not appear to be sensitive to this type of disturbance.
OTHER INSTRUMENTS IN OPERATION:

(1) Seismographs
   (a) One Carnegie DTM system
   (b) One Wilson-Lamison vertical system

(2) Magnetic Instruments
   (a) Three variographs
   (b) One magnetic film recorder
   (c) Magnetometers

(3) Station Accessories
   (a) Two portable Carnegie DTM seismic recorders
   (b) Nine DTM Mark IV explosion seismometers
   (c) Underwood-Olivetti electric computer and Triumphator mechanical computer

(4) Each of six outlying seismograph stations has a complete DTM seismograph system, including a Ulysses Nardin marine chronometer, BC 312 receiver, and a semi-automatic time correction system.

RESEARCH PROJECTS IN PROGRESS:

The seismograph facilities of the Instituto Geofisico are used for research along the following lines:

(1) Attenuation of seismic energy is investigated by comparing the energy released as micro-earthquakes recorded at the seismograph stations.

(2) Seismic data is used to investigate the structural conditions under the Andes Mountains.

(3) Investigations of tectonic aspects related to seismic activity resulted in the discovery of an active fault. The San Agustin faulting system is the source of most of the local shocks, and the data from the network of stations is being used to delineate this fault.

(4) Investigations of magnitude and frequency of micro-tremors include disclosure of some shocks considered to be associated with the volcano El Misti.
STATION FACILITIES

STATION: Athens, Greece

STATION DIRECTOR:
   Professor A. Galanopoulos

STATION ABBREVIATION: ATH

MAILING ADDRESS:
   Professor A. Galanopoulos
   Director, Seismological Laboratory
   University of Athens
   4 Massalias Street
   Athens, Greece

TELEPHONE NUMBER:
   University: 610031
   Observatory: 562664

CABLE ADDRESS: Not given

ELEVATION: 95 meters

GEOGRAPHIC COORDINATES:
   Latitude: 37° 58' 22'' N
   Longitude: 23° 43' 0'' E

HISTORY OF STATION:

<table>
<thead>
<tr>
<th>Director</th>
<th>Date</th>
<th>Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. Eginitis</td>
<td>1892-1910</td>
<td>Agamemnon 1898</td>
</tr>
<tr>
<td>N. Critikos</td>
<td>1910-1945</td>
<td>Mainka (hor) 1910</td>
</tr>
<tr>
<td>A. Galanopoulos</td>
<td>1949-</td>
<td>Wiechert (hor) 1924</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wiechert (vert) 1928</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Denioff (vert) 1957</td>
</tr>
</tbody>
</table>

World Array equipment began operating here on April 2, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
A local topographic map is not available. The station is located in Athens, approximately 100 km from the nearest mountains (Dinaouden Branch) and 10 km from the Mediterranean Sea.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The observatory is approximately 200 meters from main streets or other activity. There are no tall buildings nearby. It is approximately 2 km from the university campus.
LOCAL GEOLOGY:

The observatory is located on a formation of thick Cretaceous limestone.

STATION AND PIER CONSTRUCTION

PIERS:

The piers are constructed of concrete. The bedrock of Cretaceous limestone was dug out approximately 4 feet for the piers. The piers extend one foot above floor level. In the absence of an alternative, the floors were constructed on bedrock. This will disturb the long-period instruments if one walks into either seismometer room.

VAULT TEMPERATURE AND HUMIDITY:

Temperature control is excellent. There is no more than 2°C variation throughout the vault. An air blower is present for air circulation in the SP room and the recording room, but it will not be used because it disturbs the LP galvanometers. The mean temperature is 16°C. The vault is new, and at the present time humidity is very high. They are improving each day. Calcium chloride has been placed in each room to absorb the moisture. Months of highest humidity are February, March, and April.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 12500
SP N-S: 12500
SP E-W: 12500
LP Z: 1500
LP N-S: 1500
LP E-W: 1500

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 1 and 4 sec

AVERAGE AMPLITUDES: Not given

REMARKS: Athens is located on the Alpide Earthquake Belt. The station records a yearly average of 2500 quakes in a radius of 500 km. In Greece alone there are 900 quakes a year.
OTHER INSTRUMENTS IN OPERATION:
Benioff vertical seismograph
Wiechert astatic horizontal seismograph
Wiechert vertical seismograph
Mainka horizontal seismograph (for near shocks)
Kritikos horizontal seismograph (for strong local shocks)

RESEARCH PROJECTS IN PROGRESS: Not given
STATION FACILITIES

STATION: Baguio City, Philippines

STATION DIRECTOR:
James J. Hennessey, S.J.

STATION ABBREVIATIONS: BAG

MAILING ADDRESS:
Manila Observatory
Mirador, Baguio City
Philippines
Attn: Seismology

TELEPHONE NUMBER:
61-88

CABLE ADDRESS:
RJMALO
Baguio Observatory
John Hay Air Base P I

GEOGRAPHIC COORDINATES:
Latitude: 18° 24' N
Longitude: 120° 36' E

ELEVATION:
1507 meters

HISTORY OF STATION:
A seismic station was maintained at Mirador from 1930 until the outbreak of World War II under the direction of Fr. William Repetti, S.J. In 1952 the present vault was completed and observations began with Fr. Charles Deppermann, S.J., as Director of the Observatory and Fr. Bernard F. Doucette, S.J., as chief of the Division. Fr. Doucette holds this position at present. In 1957 Fr. James J. Hennessey, S.J., was appointed Director of the Manila Observatory. World Array equipment began operating on March 31, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The seismic station is located on the east side of Mirador Hill about 2 km west of the city of Baguio. Mirador rises about 400 feet above the Baguio plateau and forms one of the hills that fringe the city. It is separated from Dominican Hill by a narrow saddle. Topography is moderately steep, especially along its SE, N, and NW flanks. Vegetation consists of secondary growth of pine trees and low shrubs typical of limestone areas.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
Manila Observatory is located on Baguio City's outskirts, high up a mountain. The site is well removed from cultural noise sources, such as roads and buildings, but there are trees.
nearby and wind noise is noticeable. The vault proper is underground, well away from other observatory facilities and from drains.

LOCAL GEOLOGY:

Mirador Hill is typical of the extensive Mirador limestone of the Baguio area. The exposure of this limestone shows a thickness of about 400 feet. (The limestone quarry of the city of Baguio was formerly in this formation at the northern base of Dominican Hill.) This limestone formation is fairly pure coralline limestone and is dense, metamorphosed into marble in places. Samples show occasional coral remains.

STATION AND PIER CONSTRUCTION

PIERS:

The pier is constructed of reinforced concrete and is isolated from the floor. It extends 33 inches above the floor level. Below the floor level it extends 18 inches, where it is attached directly to the Mirador limestone. Cabling is passed along the top of the room from the console into the seismometer vault, where it joins seismometer cabling. From there it runs through a 1 1/2-inch water pipe into the galvanometer or the recording area and is dispersed to necessary points.

VAULT TEMPERATURE AND HUMIDITY:

Wide seasonal or daily temperature fluctuations are not expected. Average high: 75°F in April, May, and June. Average low: 72°F in December, January, and February.

Humidity is controlled and is at present no problem, but it will become high during the summer months. The 1/8 hp dehumidifier unit is portable and cyclic. It doesn't appear to be a noise source; however, it is not to be used in the seismometer area of the vault. The humidity is seasonal, but not excessive enough to ever require extraordinary preventive measures. During the winter it may be 45% to 60%; during the summer, as high as 90% for periods of several days. The vault area (including all equipment) is watertight, and the humidity referred to is strictly atmospheric.
CROSS-SECTION, LONG SIDE OF L-SHAPED SEISMOMETER PIER
BAGUIO CITY STATION

SEISMOMETER ROOM
STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 25000
SP N-S: 25000
SP E-W: 25000
LP Z: 1500
LP N-S: 1500
LP E-W: 1500

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 6 sec

AVERAGE AMPLITUDES: Not given

REMARKS: Microseisms are at their highest amplitude during the summer months, or the typhoon season. The predominant microseisms during this season have a period of 6 sec. The station is removed from local noise sources such as roads and trolley lines. Other than an access road to Mirador Hill, the nearest highway is 0.8 km away. There are occasional quakes with epicenters located within the chain of islands comprising the Philippines. This somewhat limits the degree of magnification at which the instruments can be operated.

MAN-MADE NOISE:

Not given

OTHER INSTRUMENTS IN OPERATION:

(1) Strong motion Sprengnethers
(2) Visual recorders—Sprengnethers for NS, EW
(3) This observatory also operates an ionosphere station.

RESEARCH PROJECTS IN PROGRESS: Not given
STATION FACILITIES

STATION: Bermuda
(Columbia University Seismograph Station)

STATION DIRECTOR:
Mr. G. R. Hamilton

TELEPHONE NUMBER:
39725

GEOGRAPHIC COORDINATES:
Latitude: 32° 22' 46" N
Longitude: 64° 10' 52" W

HISTORY OF STATION:
World Array equipment began operating here on February 1, 1962.

STATION ABBREVIATIONS: BEC

MAILING ADDRESS:
Mr. G. R. Hamilton
Navy Sofar Station
A. P. O, 856
New York, New York

CABLE ADDRESS:
Oceaninist

ELEVATION: 41 meters

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
Not given

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located in Fort George, an old fort on top of a high hill. The seismometer and recording vaults are on the bottom floor; the console is in the office on the third floor. The Bermuda Harbour Signal Station is located on top of the fort. The nearest buildings are the St. George Hotel and the Oxford Laundry. These two buildings are about 800 feet away.

LOCAL GEOLOGY:
The Bermudian Islands are composed of aeolian limestone forming irregular hills of about 200 to 250 feet. These limestones consist chiefly of blown shell dust, very irregularly stratified, and are plastered over with layers of coral and other calcareous organisms. The Bermudas were formerly much more extensive than now and may be upon the summit of a submerged volcano. There are evidences of small oscillations of levels, but even more of great elevations or depressions. The surface soil is a friable red earth, also found in ochreous strata throughout the limestones. It is generally mixed with vegetable matter and coral sand. There are no streams or wells of fresh water.
STATION AND PIER CONSTRUCTION

PIERS:
The pier is a coarse-textured concrete and was constructed in December 1960. It is isolated from the vault floor on the northeast side and ends by about 4 inches and from the southwest wall by about 2 feet. The 4-inch spaces are partially filled with sand. The pier is attached to bedrock which in this case is coral-limestone. The north end of the pier is about 2.5 feet below the floor level, and the south end about 5 feet.

VAULT TEMPERATURE AND HUMIDITY:
There are no wide seasonal or daily temperature fluctuations at this station. The average high and low temperatures are 71°F and 68°F in both the recorder and seismometer vaults. The lowest temperatures occur in February, the highest in August. The temperature in the console room (office) varies from 65°F to 80°F.

The seismometer vault contains a small dehumidifier that operates continuously, drawing 3/4 gallon of water from the vault each day. The humidity is about 94%, but will probably decrease as the new pier ages. In the recording vault the humidity is about 75%. A small portable dehumidifier is shared by the recording vault and another vault that contains some of the station's Columbia University equipment. The console is kept in the office, which contains no environmental controls; here the variance in humidity is from 50% to 100%.
STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 12500
SP N-S: 12500
SP E-W: 12500
LP Z: 1500
LP N-S: 1500
LP E-W: 1500

Both systems could operate at increased magnification from April to September.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 4 to 8 sec

AVERAGE AMPLITUDES: 6 mm

REMARKS: The seasonal amplitude fluctuations are greatest in January, least in July. Microseisms are present from September to April, their average amplitude is 6 mm.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest highway is 0.8 km
There are no railroads, rivers, or dams in this area.

REMARKS: There are two other possible noise sources: a quarry 9.6 km away which has approximately two blasts per year and a nearby golf course.

OTHER INSTRUMENTS IN OPERATION:

(1) Two Milne-Shaw horizontal seismographs (period 12 sec, Magnification 250).
(2) Microbarograph

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Balboa Heights, Canal Zone

STATION DIRECTOR:
W. H. Esslinger

STATION ABBREVIATION: BHP

MAILING ADDRESS:
Chief Hydrographer
Panama Canal Company
280 Administration Building
Balboa Heights, Canal Zone

TELEPHONE NUMBER:
Balboa - 2605

CABLE ADDRESS:
Not given

GEOGRAPHIC COORDINATES:
Latitude: 8° 57' 39'' N
Longitude: 79° 33' 29'' W

ELEVATION:
36 meters


STATION ENVIRONMENT

LOCAL GEOGRAPHY:

The unevenness of the land surface in the Canal Zone is rather striking, particularly so in the central and Pacific areas. The hills, ranging up to nearly 1000 feet high, are mostly conical, but have many angular shoulders and irregular, buttress-like flank supports. Some of the peaks are really short ridges, with slightly curved alignment. There are no well-defined, long mountain ridges. Groups of peaks, separated by irregular valleys, may have wide sections where the rocks are harder. A smoother land surface occurs locally, where bedded rocks of even hardness are present over any considerable area. This rather unusual topographic variation is largely the result of stream erosion and weathering. The land surface has been periodically uplifted and depressed with respect to sea level. The latest movement of the land is a slight rise of four or five feet, as revealed by an old raised beach near Colon and Toro Point. The rise and fall of the land here is, of course, extremely slow, perhaps measurable in inches per century.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:

See map of Balboa Heights.
LOCAL GEOLOGY:

All rocks of the Canal Zone are very young, having been formed in the Tertiary period. These rocks are largely of volcanic origin and generally of basic character, that is, rich in iron, magnesium and calcium-bearing minerals. There are minor amounts of acid rocks, rocks that contain some free quartz. The basic rocks are considerably altered into hydrated, slippery minerals such as kaolin, chlorite, and serpentine. Such mineral grains, in finely divided form, promote sliding. The quartz grains in the acid rocks are antislide factors.

The structure of the Canal Zone is extremely complex and presents many unique features. In general, geological structures along the alignment of the existing Canal and adjacent areas are characterized by a broad, complex, faulted, plunging anticlinal fold with relatively minor folding in the flanking Tertiary sedimentary strata. Axial trend of the anticline is NE-SW, or nearly parallel to the coast lines, and the sedimentary formations usually dip toward the oceans. The Canal alignment is thus nearly perpendicular to the principal structural axis of the Isthmus. Lesser structural features in the Canal Zone present a remarkable conformity of alignment. The major faults and many of the minor features, as well as axes of the folds, are roughly parallel in trend. There is a very apparent regional dip of the younger sediments away from the central core of the Isthmus, particularly on the Caribbean side, which can be largely attributed to the original inclination of the bedding caused by deposition on seaward-sloping surface and to subsequent differential compaction in the sedimentary beds, which thicken away from the central core of basement rocks. Folding and faulting have served to accentuate the anticlinal resemblance of the regional structure, but it is thought that the Isthmus as a whole is not in the usual sense a fold resulting from compressive crustal movement. Earth movements have been recurrent and diversified in magnitude since deposition of the oldest rocks known in the area, the older formations being usually more folded, faulted, and otherwise altered than the younger strata.
<table>
<thead>
<tr>
<th>Pleistocene</th>
<th>Pleistocene Formations</th>
<th>River Alluvium Muds and Silts Gravel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mioocene</td>
<td>Caribbean Limestone</td>
<td>Shell, Marl, and Massive Limestone</td>
</tr>
<tr>
<td>Mioocene</td>
<td>Panama Formation</td>
<td>Light-Colored Tuff Beds, Argillite, etc.</td>
</tr>
<tr>
<td>Mioocene</td>
<td>Gatun Formation</td>
<td>c Clay Beds b Fine Sandstone a Argillite = Clay Rock</td>
</tr>
<tr>
<td>Mioocene</td>
<td>Calimito Formation</td>
<td>c Sandstone b Limy Agglomerate a Sandstone</td>
</tr>
<tr>
<td>Oligocene</td>
<td>Emperador Limestone</td>
<td>Marine Limestone Many Corals</td>
</tr>
<tr>
<td>Oligocene</td>
<td>Cucaracha Formation</td>
<td>Massive Soft Argillite, etc.</td>
</tr>
<tr>
<td>Oligocene</td>
<td>Culebra Formation</td>
<td>Marine Carb(^1) Shale, Clay, Tufts, Sandstone</td>
</tr>
<tr>
<td>Oligocene</td>
<td>Bohio Conglomerate</td>
<td>Sandstone and Conglomerate</td>
</tr>
<tr>
<td>Oligocene</td>
<td>Las Cascadas Agglomerate</td>
<td>Volcanic Agglomerate, Tufts, and Lava Flows</td>
</tr>
<tr>
<td>Oligocene</td>
<td>Bas Obispo Formation</td>
<td>Volcanic Tuff, Agglomerate, and Breccia</td>
</tr>
<tr>
<td>Miocene (Mostly)</td>
<td>Basalt</td>
<td>3 Andesite</td>
</tr>
<tr>
<td>Miocene (Mostly)</td>
<td>Meta-Breccia</td>
<td>2 Diorite</td>
</tr>
<tr>
<td>Miocene (Mostly)</td>
<td>Rhyolite</td>
<td>1 Granodiorite</td>
</tr>
</tbody>
</table>

GEOLOGIC COLUMN
CANAL ZONE FORMATIONS
PIERS:

The seismograph vault is located in the basement of the Administration Building of the Panama Canal Company and was constructed with the building in 1914. The piers are made of reinforced concrete and are separated from the vault floor by a one-inch space; based on undisturbed rhyolite, they are about 14 feet deep and about 30 inches above the vault floor. All cables passing from the console unit into the vault are in conduit pipe. The signal cables from the seismometers to the galvanometers are not enclosed in conduit. None of the components of either system are bolted to the piers.

VAULT TEMPERATURE AND HUMIDITY.

The vault is temperature controlled by a chilled water cooling system operating at all times and keeping the vault at a constant 75°F to 78°F. Rooms surrounding the vault are also temperature controlled by the same method, from a central system, whereas the vault has its own system. This aids in keeping any great temperature variation outside from affecting the temperature within the vault. The average seasonal temperature variance is about 1°F to 2°F (from rainy season to dry). The rainy season is from mid-October to mid-December. The average yearly temperature is around 80°F, with daily variations greatest during the dry season. This variance is from 75°F to 90°F. The high temperature occurs at 1200 hours, EST, and the low at 0600 hours, EST. During the rainy season the temperature variance is much less, about 10°F. These variances have little effect on the vault.

The relative humidity varies daily during the dry season about 30% and during the rainy season about 15 to 20%. However, this does not appreciably affect the vault. The vault is partially humidity controlled, as is the whole building, by a pre-heating system which pre-heats the air slightly and tends to keep the humidity constant,
BALBOA HEIGHTS INSTALLATION
STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 12443
SP N-S: 12493
SP E-W: 12493
LP Z: 743
LP N-S: 762
LP E-W: 744

None of the systems can operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS:

SP: 1-2 sec
LP: 4-6 sec

AVERAGE AMPLITUDES:

SP Systems, 1000 μ
LP Systems, 250 μ

REMARKS: The amplitude of normal microseismic activity definitely shows an increase during the rainy season (mid-October to mid-December). There is also an increase, above the norm, of microseismic activity when a storm front moves across the Isthmus during the rainy and dry seasons. But the microseismic activity is noticeably less during the dry season, despite the presence of steady winds, which appear to have very little influence on normal activity. Amplitudes are also less during this season.

There appears to be a definite correlation between the variation in barometric pressure and microseismic activity, which could possibly be caused by an attempt of nature to equalize the differential in pressure, and, consequently, to cause enough disturbance to affect the seismometers.

Volcanic activity is practically nonexistent in the area. Numerous small local quakes are recorded. The focal point of these quakes is primarily the shelf area in the Bay of Panama. This area is also the center of recorded disturbances caused by caving and shifting along the shelf. The presence of many small slides on the Isthmus, due to its geological makeup, contributes to the existence of many disturbances on the records which are not man-made, yet are not to be classed as local earthquakes. Tides have no apparent effect on microseismic activity, since their period is around six hours. The possibility that tides were the trigger force for local quakes was studied some years ago; however, the instrumentation and interpretation allowed no definite correlation to be made. Wave action appears to have little effect on microseismic activity under normal conditions. However, during a heavy storm, the breakers be-
come very large and strong enough to have an effect. Their predominant period is around 8 to 10 sec.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 135 meters
The nearest highway is 270 meters

REMARKS: The station is 1.6 km from the main channel of the Panama Canal. The closest dam is 32 km away; the nearest set of locks is about 8 km distant. Train and truck traffic noise is present on records here and can easily be distinguished from other disturbances. Ships traveling through the Canal have no effect on the noise level. A large gas compressor unit located outside the building is used in the air conditioning of the Administration Building. Within the building are many small air circulating units, one of which is adjacent to the vault. It is believed that these units add to the overall noise level and could be distinguished if normal microseismic activity would permit a higher magnification setting. A quarry about 0.4 km from the station causes some disturbance; blasts set off in the quarry have been recorded.

Considerable construction work is being done on the Canal at Gaillard Cut, about 32 km northwest of the station. Several blasts, averaging around 20 tons of dynamite each, have been recorded. This project will continue for two to three years or longer. A noticeable increase of background noise appears on daily records during the week, but is relatively absent on week-ends. The increase is attributed to general building activity.

OTHER INSTRUMENTS IN OPERATION:

1) Three Sprengnether seismographs: two are horizontals and have a period of 20 sec; the vertical has a period of 1.8 sec.

2) Two Wood-Anderson horizontal seismographs: their period is 1 sec and their magnification is 1375.

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Berkeley, California

STATION DIRECTOR:
Dr. Bruce Bolt

STATION ABBREVIATION: BKS

MAILING ADDRESS:
Seismographic Station
University of California
565 Earth Sciences Bldg.
Berkeley 4, California

TELEPHONE NUMBER:
Thornwall 5-6000 (Ext. 3976 & 3977)
(Area Code 415)

CABLE ADDRESS:
Same as mailing address

GEOGRAPHIC COORDINATES:
Latitude: 37° 52' 36" N
Longitude: 122° 14' 6"

ELEVATION:
276 meters

HISTORY OF STATION: World Array equipment began operating here on June 8, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
See topographic map.

STATION’S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is in a canyon east of the main campus. The closest buildings are 0.8 km away.

LOCAL GEOLOGY:
The tunnel of the University of California Seismographic Station was cut into the upper part of the Claremont Formation. This formation lies stratigraphically below the Orinda Formation, which probably can be found within 500 feet of the tunnel. These units are a part of the western limb of a syncline. The attitude of the bed near the adit (tunnel) was found to be: strike, N 77° W; dip, 52° E.

The Claremont Formation was named and described by Lawson.² The unit is a typical part of the extensive Monterey Formation. The formation, laid down in a Miocene sea, consists of

thin layers of cherty material alternating with shale. Page also describes the occurrence of
dolomite lenses, and sandstone and diabase dikes in the Claremont unit.²

The chert of the formation is a chocolate brown which, upon weathering, bleaches to a near
white. The cherty strata is generally hard and brittle; it tends to resist weathering more than
the shale, and this gives the chert a more prominent appearance in the outcrop.

Because of the higher degree of weathering of the shale, the shale appears to be lighter in
color than the chert in most cases. In the unweathered state both the shale and the chert are
chocolate brown. The shale exhibits a bituminous quality, characteristic of the Monterey
rocks.

The lens of dolomitie sandstone is hard and brittle, weathering about the same as the chert.
The extent of the lens is not thought to be very great. Some material resembling the sandstone
was reportedly cut into near the adit, but this is not near the vault room which is in the harder
rock. All rock exposed and weathered becomes quite friable. The result of this is the accumu-
lation of rubble at the base of the cut.

² Ben M. Page, "Geology of the Broadway Tunnel, Berkeley Hills, California," Econ. Geol.,
1951, pp. 146-165.
STATION AND PIER CONSTRUCTION

PIERS:

Piers are constructed of reinforced concrete, but there is no isolation from floor and walls.

VAULT TEMPERATURE AND HUMIDITY:

The temperature is very stable and is not controlled. No seasonal or daily temperature fluctuations are expected. A ventilating system in all rooms except the seismometer vault should help reduce humidity, which is slightly higher than normal at present because of the necessity of pumping grout in the earth above the vault. As moisture evaporates from the grout, humidity will diminish. No wide seasonal fluctuations in humidity are expected.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 25000 (at one sec)
SP N-S: 25000 (at one sec)
SP E-W: 25000 (at one sec)
LP Z: 3000 (at 30 sec)
LP N-S: 3000 (at 30 sec)
LP E-W: 3000 (at 30 sec)

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 2 3.5 ccc

AVERAGE AMPLITUDES: 1000 µ (0 to peak)

REMARKS: There are no seasonal amplitude fluctuations. There is a microseismic build-up during storms, but otherwise there is only normal background throughout the year. Other natural seismic disturbances consist of occasional local earthquakes. The station is in a seismic area.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 3.2 km
The nearest highway is 3.2 km
The nearest dam is 4.8 km
The nearest river is 40 km
VAULT

RECORDING ROOM

SEISMOMETERS
REMARKS: The site is isolated from cultural noises. The nearest highway is 3.2 km away and should give no trouble. Lawrence Radiation Laboratory, about 0.8 km from the site, could cause some trouble.

OTHER INSTRUMENTS IN OPERATION:

<table>
<thead>
<tr>
<th>Instrument</th>
<th>$T_0$</th>
<th>$T_g$</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benioff Z</td>
<td>1</td>
<td>0.4</td>
<td>30000 (approx.)</td>
</tr>
<tr>
<td>Wood-Anderson N-S, E-W</td>
<td>0.8</td>
<td></td>
<td>2800</td>
</tr>
<tr>
<td>Galitzin Z</td>
<td>11.59</td>
<td>11.59</td>
<td>850</td>
</tr>
<tr>
<td>Galitzin N-S</td>
<td>12.1</td>
<td>12.12</td>
<td>1327</td>
</tr>
<tr>
<td>Galitzin E-W</td>
<td>11.70</td>
<td>11.67</td>
<td>1052</td>
</tr>
<tr>
<td>Press-Ewing Z</td>
<td>30</td>
<td>90</td>
<td>2050 (approx.)</td>
</tr>
<tr>
<td>Press-Ewing E-W, N-S</td>
<td>30</td>
<td>103, 104</td>
<td>2050 (approx.)</td>
</tr>
<tr>
<td>Sprengnether Z</td>
<td>2</td>
<td>2</td>
<td>3290</td>
</tr>
<tr>
<td>Sprengnether N-S, E-W</td>
<td>2</td>
<td>2</td>
<td>1950 (approx.)</td>
</tr>
<tr>
<td>Benioff Z</td>
<td>1</td>
<td>8</td>
<td>variable</td>
</tr>
<tr>
<td>Strong Motion N-S, E-W</td>
<td>0.8</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

RESEARCH PROJECTS IN PROGRESS:

1. Studies of small earthquakes and aftershocks
2. Studies of mechanism of faulting
3. Studies of creep on a fault
4. Studies of seismic velocities and structure of earth's crust and upper mantle
5. Focal depth distribution of local earthquakes
STATION FACILITIES

STATION: Blacksburg, Virginia

STATION DIRECTOR:
Dr. C. E. Sears

STATION ABBREVIATION: BLA

MAILING ADDRESS:
Box 522
Blacksburg, Virginia

TELEPHONE NUMBER:
PR 2-8261 (Ext. 279) PR 2-9145

CABLE ADDRESS:
Same as mailing address

GEOGRAPHIC COORDINATES
Latitude: 37° 12.675' N
Longitude: 80° 25.23' W

ELEVATION:
624 meters

HISTORY OF STATION:
The station here was established for participating in the standardized World Array program. Dr. Sears is the first director. World Array equipment began operating here on September 4, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is located on an upland surface between the Blue Ridge to the south and the Allegheny Mountains to the north. The town of Blacksburg is about 1.6 km to the north and the town of Christiansburg about 8 km south. New River is about 8.8 km to the west.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is isolated from all activity on the experimental dairy farm of Virginia Polytechnic Institute. There are no tall buildings or other man-made structures nearby.

LOCAL GEOLOGY:
The station is situated in an overthrust region and lies on a formation of Cambrian dolomite of unknown thickness.
STATION AND PIER CONSTRUCTION

PIERS:

The piers are set in Cambrian dolomite and made of concrete. The bedrock was cleaned and two inch holes were drilled in the rock to give a good binding surface. Piers are isolated from the floors and the building proper sits on gravel or clay.

VAULT TEMPERATURE AND HUMIDITY:

No environmental control other than heaters is present and probably no other is needed. The building is well constructed, having concrete walls one foot thick sealed on the outside and covered with three feet of dirt. Heaters are installed in the console room, developing room, and entrance hallway, but not in the seismometer rooms or recording room. Wide seasonal temperature fluctuations are expected; however, daily fluctuations should be slight. Temperature fluctuations are not expected to be a problem.

Because of the drying of the concrete, humidity is a little higher than normal. A dehumidifier installed in the developing room helps to cut down the moisture there.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 100000
SP N-S: 100000
SP E-W: 100000
LP Z: 6000
LP N-S: 6000
LP E-W: 6000

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: LP: 4.3 to 5
SP: 1 to 3.5

AVERAGE AMPLITUDES: LP SP
800 700 microns (0 to peak)

REMARKS: From our observations the greatest microseismic activity will be during periods of storms (hurricane season). This is a new station and adequate data on microseismic activity and other natural seismic disturbances is lacking.
STATION INSTALLATION, BLACKSBURG, VIRGINIA
MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 0.6 km (branch line); 3.8 km (N & W R.R.)
The nearest highway is 1.6 km
The nearest dam: none
The nearest river is 8.8 km

REMARKS: The only source of noise expected to affect the recordings is a quarry about 6.4 km from the station. There is some blasting here and although the charges are usually small, we have reason to believe that they are detected by the instruments. The Norfolk and Western Railroad (main line) is about 3.8 km south of the station. A branch line of the N&WRR is about 0.6 km east of the station. A maximum of two or three trains of freight cars are brought in each day.

OTHER INSTRUMENTS IN OPERATION:

None

RESEARCH PROJECTS IN PROGRESS:

Not given
STATION FACILITIES

STATION: Bogotá, Colombia

STATION DIRECTOR:
J. Emilio Ramirez, S.J.

STATION ABBREVIATION: BOG

MAILING ADDRESS:
Fr. Ramirez
Universidad Javeriana
Carrera 7th No. 46-62
Bogotá, Colombia

TELEPHONE NUMBER:
45-5021

CABLE ADDRESS:
Universidad Javeriana
Bogotá

GEOGRAPHIC COORDINATES:
Latitude: 4° 37' 23" N
Longitude: 74° 03' 54" W

ELEVATION:
2658 meters

HISTORY OF STATION:
World Array equipment began operating here on May 4, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is located on the western slope of the Bogotá Cordillera and behind the College of San Bartolome. It is about 400 meters east of the entrance to the college and about 3 km east of the center of Bogotá.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is in the side of a mountain on the NE edge of Bogotá. The nearest structure is a Catholic grade school, about 200 meters west and about 50 feet lower in elevation. West of the grade school is a high school, about 400 meters west of the station and about 100 feet lower in elevation. A main traffic artery of Bogotá is 800 meters west of the station and 200 feet lower in elevation; on this street are several tall office buildings about 1.6 km from the station. There is a school for girls 800 meters east of the station and 150 feet higher in elevation. Except for the school, there is very little activity east of the station; to the west it is surrounded by Bogotá. Nearest buildings are 500 meters NW to 1000 meters SW.
LOCAL GEOLOGY:

The vault is partially excavated from a sandstone formation and partially built outside the formation. The rock partially excavated for the vault consists of several beds of hard siliceous, coarse-grained sandstone traversed by several hematite veins and interbedded with thin beds of clay.

STATION AND PIER CONSTRUCTION

PIERS:

Both seismometer piers are constructed of concrete and have been extended on all sides to make them large enough for the instruments. The extensions go below the floor level, but not to the depth of the original piers. The piers are anchored in a massive, well-cemented sandstone formation and are isolated from the building floor. The galvanometer pier is made of brick, built up from the floor. The recording pier is a solidly constructed wooden bench.

VAULT TEMPERATURE AND HUMIDITY:

Temperature control is unnecessary. A dehumidifier is present in the recording room to keep the humidity at a reasonable level. There is very little daily or seasonal temperature fluctuation in Bogotá. Because of the construction of the station (it is carved into the side of a mountain) fluctuation is negligible in the instrument rooms.

Humidity is the big problem at this station. The pole pieces on SP galvanometers have already begun to rust. Paper on the recorders is wrinkled in the mornings from humidity. A dehumidifier is in the recording room. After the vault is closed, operating the dehumidifier for two hours per day will probably keep the humidity at a reasonable level in the recording room. Desiccant was placed inside the seismometers before they were sealed.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z: 25000</td>
<td>None of the systems could operate at increased magnification.</td>
</tr>
<tr>
<td>SP N-S: 25000</td>
<td></td>
</tr>
<tr>
<td>SP E-W: 25000</td>
<td></td>
</tr>
<tr>
<td>LP Z: 3000</td>
<td></td>
</tr>
<tr>
<td>LP N-S: 3000</td>
<td></td>
</tr>
<tr>
<td>LP E-W: 3000</td>
<td></td>
</tr>
</tbody>
</table>

BOG-2
BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 1 and 6 sec

AVERAGE AMPLITUDES: 0.6 \mu

REMARKS: Seasonal amplitude fluctuations seem to be associated with weather conditions. Not much work has been done on microseisms, but two different types, having periods of 1 and 6 sec, are on the records. The 1-sec waves are thought to be caused by wind in the trees surrounding the station. The only other natural seismic disturbances recorded are local earthquakes.

MAN-MADE NOISE:

FROM THE SEISMMOMETER VAULT:

The nearest railroad is 2 km
The nearest highway is 3/4 km
The nearest dam is 15 km
The nearest river is 10 km

REMARKS: Most of the man-made noise which limits the magnification of the short-period systems is caused by Bogotá traffic, which is evidenced by the buildup of noise on the records about six o'clock in the morning. The noise level is high during the day and then diminishes at about six or seven o'clock at night.

OTHER INSTRUMENTS IN OPERATION:

A USC&GS accelerometer and a two-component, horizontal strong motion instrument are in operation at the station. On the university campus there is a meteorological and an ionospheric station.

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Bulawayo, Southern Rhodesia
STATION DIRECTOR:
Mr. C. B. Archer
STATION ABBREVIATION: BUL
MAILING ADDRESS:
Goetz Meteorological Observatory
P. O. Box 562
Bulawayo, Southern Rhodesia
TELEPHONE NUMBER:
60641
CABLE ADDRESS:
MET
Bulawayo
GEOGRAPHIC COORDINATES:
Latitude: 20° 08.6′ S
Longitude: 28° 36.8′ E
ELEVATION:
1320 meters

HISTORY OF STATION:
Seismic recording has been done at this station since January 31, 1959. Mr. Archer has always been the officer in charge of the station. World Array equipment began operating here in January, 1963.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is located in the NE part of the city of Bulawayo. The general area is relatively flat. A few small hills are north and east of the city. The Matsheumhlope River is 2.4 km west of the station.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located on the grounds of the Goetz Meteorological Observatory. There are small homes in the area, which also has many trees. A school adjoins the observatory grounds.

LOCAL GEOLOGY:
The station is situated in the middle of a lava flow. The flow is from 100 feet to 120 feet wide and has an East to West strike. The station rests on a stable block of lava and allied greenstone schists, which is isolated by two fracture belts 300 feet apart. There is evidence of limited decomposition and fracturing of the rock to a depth of 40 feet. Thereafter it appears to be solid to a depth of 90 feet, after which minor fracturing can be expected.
This locality as a whole cannot be regarded as stable. A well-defined fault with marked displacement is less than 1000 yards to the east. Numerous quartz veins and stringers have been deposited in these zones of weakness. Normal weathering has further weakened the host rock alongside the quartz veins. There are a number of known fracture belts to the north and south. The fracture belts probably contain numerous clay seams which vary in depth to about 200 feet.

STATION AND PIER CONSTRUCTION

PIERS:
Seismometer and galvanometer piers are anchored 4 to 6 feet in soft decomposed lava intrusions. They are made of concrete and have smoothly-finished tops. Recorder piers are made of brick, built up from the floor, and have concrete tops.

VAULT TEMPERATURE AND HUMIDITY:
No environmental control is present. Maximum daily temperature range is about \(10^0\)\(F\). Mean seasonal range is \(22^0\)\(F\). Highest temperatures (\(83^0\)\(F\)) occur in October and November. Lowest temperatures (\(55^0\)\(F\)) occur in June and July. There will be a wide seasonal fluctuation in humidity in the instrument rooms. Low readings (15%) occur in August and September and high readings (80%) in January and February.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>100000</td>
</tr>
<tr>
<td>SP N-S</td>
<td>100000</td>
</tr>
<tr>
<td>SP E-W</td>
<td>100000</td>
</tr>
<tr>
<td>LP Z</td>
<td>1500</td>
</tr>
<tr>
<td>LP N-S</td>
<td>1500</td>
</tr>
<tr>
<td>LP E-W</td>
<td>1500</td>
</tr>
</tbody>
</table>

None of the instruments can operate at increased magnification.
FLOOR PLAN, SEISMOLOGICAL STATION, BOGOTA
BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 1 and 6 sec

AVERAGE AMPLITUDES: 0 to .06 μ

REMARKS: Microseismic activity is most intense during the winter months, from June to September. The winter disturbances are believed to be due to pressure movements over the southern part of the African continent. During summer thunderstorms, intense microseismic activity also occurs.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 4.8 km
The nearest highway is 0.4 km
The nearest dam is 8 km
The nearest river is 2.4 km

OTHER INSTRUMENTS IN OPERATION:

(1) A set of three-component Willmore SP seismometers
(2) A microbarograph

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Caracas, Venezuela

STATION DIRECTOR:
Dr. Gunther Fiedler

STATION ABBREVIATION: CAR

MAILING ADDRESS:
Hidrografia y Navegacion
Observatorio Cagigal
Instituto Seismologico
Apartado 6745
Comandancia General de la Marina
Caracas, Venezuela

TELEPHONE NUMBER:
414392 (EXT. 176)

CABLE ADDRESS:
Not given

GEOGRAPHIC COORDINATES:
Latitude: 10° 30' 24" N
Longitude: 66° 55' 39" W

ELEVATION:
1035 meters

HISTORY OF STATION:
Instituto Seismologico was constructed in 1954. In June 1955, Dr. Fiedler came from the Stuttgart station and set up the existing instrumentation; he has been Chief of the Instituto Seismologico ever since. The Observatorio Cagigal was founded in 1888 under the Ministry of Public Instruction. In 1958-1959, the observatory came under the Commandancia General de la Marina (Venezuelan Navy). The observatory is now under the Hydrographic and Navigation Service of the Marina. Carlos Porras Rodrigo, Capitan de Fragata, is present director of the Observatorio Cagigal. World Array equipment began operating here May 24, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The seismological observatory is located on a hill within the city of Caracas. There are no significant rivers nearby. The Caribbean Sea is 11.2 km north of the station; a mountain ridge with an elevation of 1500 meters separates the city from the sea.
STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:

The principal building of the observatory is the three-story administration building, which is irregularly shaped. It is about 40 feet east of the Instituto Seismologico Building. The hill on which the observatory is located is surrounded by numerous very small dwellings.

LOCAL GEOLOGY:

The seismograph piers of the Cagigal observatory rest upon highly folded, upper-Cretaceous, metamorphic rocks composed of micaceous schists, talc, and phyllites with occasional stringers of quartz or carbonates. Although the depth of weathering in many nearby places reaches 30 to 50 meters, relatively unweathered rock was found at only a few meters depth at the observatory (the top of a steep hill had been leveled for construction). Correlation of the bedrock at this site has not been attempted, but the rock seems to fit the description of the Lower Paracotos formation.

The region around Caracas lies within the Coast Range Province (Cordillera de la Costa) of Venezuela. The Coast Range extends east to west along the Caribbean from the Lara depression in the state of Lara to the end of the Paria peninsula in the state of Sucre. The Northern Range on the island of Trinidad is possibly also a part of the same geologic unit. The Caribbean islands off the Venezuelan coast are sometimes considered as a part of the Coastal Range Province and sometimes as a separate unit. The Coast Range seems to be closely related to the Caribbean basin and its island arc rather than being a continuation of the Venezuelan Andes system. To the south is the Llanos sedimentary basin which now forms the interior plains of Venezuela.

The mountains of the Coast Range are composed of Cretaceous and some Pre-Cretaceous sediments which have been highly deformed and metamorphosed over a granitic nucleus Mesozoic or older. They are intruded by small bodies of basic igneous material. The granitic nucleus of the range is termed the Sebastopol complex; the metamorphosed sediments are divided into the Caracas group (lower) and the Paracotos formation (upper). The Sebastopol basal complex is described as a gneissic, biotite granite containing veins of quartz and hematite, and some chloritic schists and schistose zones. Lying unconformably over the Sebastopol rocks is the Caracas group composed of gneiss, schist, and marble metamorphosed from a lower Cretaceous section of conglomerate and arkose through limestone and shale. Over the Caracas group is the Paracotos formation composed of intensely folded chloritic phyllites in the lower part, resistant green beds of high epidote content in the middle, and phyllites, graywackes, conglomerates, and limestones in the upper part. About 5000 meters of rocks compose the metamorphic section at one location, but the section's extent at Cagigal is unknown.
TOPOGRAPHIC MAP OF CARACAS, VENEZUELA AREA
STATION AND PIER CONSTRUCTION

PIERS:
The vault is at the basement level of the Instituto Seismologico building. The recorder and galvanometer piers, attached to the vault floor, are of brick with marble facing. The LP instrumentation is in a portion of the vault extending underground beyond the limits of the building. The LP seismometer pier is of concrete extending 12 feet below the vault floor into the weathered bedrock. The lower 6 feet of this pier is widened for good contact with the bedrock and the upper 6 feet is isolated from the bedrock and the vault floor by a gap of about 15 cm, which is filled with sand. The top of the gap is covered with asphalt connected to the vault floor; the conduit passing from the piers is enclosed in plaster of Paris across this gap. The LP pier is topped with terrazo veneer and has marble sides. The SP pier is essentially the same as the LP pier, except that it is entirely vertical and extends only 6 feet below the vault floor. It rests on bedrock and has a gap 10 cm wide. The SP pier has marble sides and is topped with a rubber mat cut so that the seismometer feet may rest directly on concrete.

VAULT TEMPERATURE AND HUMIDITY:
Because the vaults are essentially underground and climate is relatively uniform, further environmental control is generally unnecessary. Wide temperature fluctuations are not expected: the highest temperature expected is about 26°C (April to August) and the lowest is about 23°C (December to January). Humidity of 50% to 60% is expected in the instrument rooms during the dry season (December through May), during the rainy season (June through November) 65% to 70% humidity is expected.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>25800</td>
</tr>
<tr>
<td>SP N-S</td>
<td>25100</td>
</tr>
<tr>
<td>SP E-W</td>
<td>25000</td>
</tr>
<tr>
<td>LP Z</td>
<td>1550</td>
</tr>
<tr>
<td>LP N-S</td>
<td>1525</td>
</tr>
<tr>
<td>LP E-W</td>
<td>1500</td>
</tr>
</tbody>
</table>

The SP E-W and all LP components could operate at twice the magnification.
CAGIGAL OBSERVATORY OF THE SEISMOLOGICAL INSTITUTE, CARACAS
BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 3 to 4 sec

AVERAGE AMPLITUDES: 0.5 to 1 $\mu$ (0 to peak)

REMARKS: The greatest microseismic activity is from July through October; the least from December through February. The 3- to 4-second period microseisms are attributed to the sea. Hurricane microseisms with a 4-second period are frequently observed. Microseisms with a 7- to 8-second period are also observed and believed caused by the sea. There is some local earthquake activity. The LP E-W appears to be slightly quieter than the LP N-S, which might be attributed to microseisms from the sea or to the fact that the hill on which the observatory is located trends E-W.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 4 km (little activity)
The nearest highway is 1 km
The nearest dam (a very small dam) is 20 km
The nearest river is 2 km
The Caribbean Sea is 11.2 km

REMARKS: There are some explosions from construction activity in and around Caracas. The noise limiting the magnification on the SP system is attributed to traffic. People, and occasionally animals, in the vault also cause disturbances. The SP E-W component is quieter and has lesser earthquake amplitudes than the other SP components.

OTHER INSTRUMENTS IN OPERATION:

1. Wieclaw NS, EW seismograph (period 1.6 sec)
2. Three Sprengnether seismometers (1.6 sec period magnification 6500)
3. Two Sprengnether horizontal seismometers (period 2.5 sec)
4. Three Calitzin seismometers (period 10.7 sec, maximum magnification 2200)
5. Bentol Z seismometer (period 1 sec, magnification 7500)
6. NS, EW strong motion seismograph (period 1 sec)
7. Askania gravity meter
RESEARCH PROJECTS IN PROGRESS:

(1) A seismo-tectonic map of Venezuela was constructed and published in 1960. This is being improved as new data become available.

(2) An investigation of the focus mechanism of a destructive earthquake in 1952 was published in 1960. Horizontal NE to SW motion was found to have taken place in the biggest active fault in Venezuela.

(3) The only continuously recording, gravimeter earthtide station in Latin America has been in operation for four years at the Instituto Seismologico. Calculations of corresponding theoretical tide have accompanied the recording. Fifty microgal per cm are recorded. The relationship between observed and theoretical tide gives the gravity factor $G = 1.236$ for this geologic unit of Venezuela. Since most places have a $G$ factor of 1.18 to 1.20, this indicates more than usual yield of the earth in this geologic unit. Sea tide and atmospheric tides have been investigated for a high $G$ factor. As a result, further study of the sea tide (harmonic constants) is being carried on.

(4) A comparison between earthtide amplitude and earthquakes in the same general longitude is being made. Many Chilean earthquakes are coincident with times that earthtides cause gravity maxima. This study is concurrent with investigations of the focal mechanism.
STATION FACILITIES

STATION: Camp Century, Greenland

STATION DIRECTOR:
Not given

STATION ABBREVIATION: CCG

MAILING ADDRESS:
Sig. C. Met (Camp Century)
U. S. Army P. R. & D. C.
A. P. O. 23
New York, New York

TELEPHONE NUMBER:
None

CABLE ADDRESS:
Not given

GEOGRAPHIC COORDINATES:
Latitude: 77° 10' N
Longitude: 61° 08' W

ELEVATION:
1800 meters

HISTORY OF STATION:
World Array equipment began operating here on November 30, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
Camp Century is located on the icecap of Greenland 240 km NE of the U. S. Air Force base at Thule and approximately 112 km north of Baffin Bay.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
Not given.

LOCAL GEOLOGY:
At Camp Century's location the ice and snow is, approximately 6000 feet thick, and it is believed that the thick ice is present at a depth of 160 feet. The instruments are located about 60 feet beneath the surface and are therefore on about 100 feet of snow.
STATION AND PIER CONSTRUCTION

PIERS:

The seismometers are in a 14-foot by 14-foot snow room, approximately 700 feet from
the recording room. They were placed on a 6-foot by 8 1/2-foot, 1800 lb metal plate. The rec-
ording piers consist of three separate wooden piers isolated from the building and frozen to
the snow at the bases. The galvanometer pier is bolted to five 12-foot iron pipes driven into
the snow inside the pier. The console is in the office adjoining the recording room.

VAULT TEMPERATURE AND HUMIDITY:

The recording room and the console room are both heated by electrical heaters mounted
on the walls. The recording room will vary from 38°F to 50°F because the room is poorly in-
sulated. In the console room temperature will vary a few degrees depending on the number of
personnel on duty. These fluctuations will cause LP galvanometer drift. The snow room has
a constant temperature of -10°F. Humidity will be approximately 50%, with large seasonal
fluctuation not expected.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>100000</td>
</tr>
<tr>
<td>SP N-S</td>
<td>100000</td>
</tr>
<tr>
<td>SP E-W</td>
<td>100000</td>
</tr>
<tr>
<td>LP Z</td>
<td>1500</td>
</tr>
<tr>
<td>LP N-S</td>
<td>1500</td>
</tr>
<tr>
<td>LP E-W</td>
<td>1500</td>
</tr>
</tbody>
</table>

None of the systems can operate at increased
magnification. During high microseismic ac-
tivity the LP systems will have to be turned
down to 750.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 1 to 7 sec

AVERAGE AMPLITUDES: Not given

REMARKS: This is a new station, and adequate data about microseisms are not available.

MAN-MADE NOISE:

Man-made noise is not present.
VAULT

SEISMOMETER ROOM

RECORDING ROOM

OTHER INSTRUMENTS IN OPERATION:
Not given

RESEARCH PROJECTS IN PROGRESS:
Not given
STATION FACILITIES

STATION: Chiangmai, Thailand
STATION DIRECTOR: Dr. Charoen Vadhanapanich
STATION ABBREVIATION: CHG
MAILING ADDRESS:
Meteorological Dept.
Bangkapi, Bangkok
Thailand

TELEPHONE NUMBER: 56178
CABLE ADDRESS:
Meteor
Bangkok

GEOGRAPHIC COORDINATES:
Latitude: 18° 47' 24'' N
Longitude: 98° 58' 37'' E
ELEVATION: 416.43 meters

HISTORY OF STATION:
This is a new station. World Array equipment began operating on March 2, 1963. Dr. Vadhanapanich is the first director.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is in the foothills of a range of mountains approximately 6.4 km from Chiangmai, a city of 500,000. The city is situated on a broad plain and is watered by the Mac Ping River.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is isolated from man-made structures and centers of activity. A road 200 yards away carries only occasional light traffic.

LOCAL GEOLOGY:
Mountains around the station are part of a range that extends into Burma, China, India, and Tibet. The local mountains are eroded and rounded. A broad plain consisting of sandstone and various alluvial deposits is in the valley below. The station itself lies on an outcrop of granite bedrock.
STATION AND PIER CONSTRUCTION

PIERS:

The vault is made of reinforced concrete, and the entire structure rests on granite bedrock. The piers, including galvo piers, are constructed of good quality concrete and are isolated from the main structure by a 3-inch barrier of tar.

VAULT TEMPERATURE AND HUMIDITY:

There is no environmental control present. Temperature averages 20°C. At present, humidity is high because of the newness of the concrete structure and lack of proper air circulation. Humidity is expected to decrease as the building loses more of its moisture content.

WORLD STANDARD SEISMOGRAPH STATION, CHIENGMAI
THAILAND

CHG-2
CROSS SECTION PIER AND VAULT FLOOR

CONTROL ROOM

63.5 cm
CHIENGMAI STATION

VAULT
STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 400000 (at 1-sec period)
SP N-S: 400000 (at 1-sec period)
SP E-W: 400000 (at 1-sec period)
LP Z: 3000 (at 30-sec period)
LP N-S: 3000 (at 30-sec period)
LP E-W: 3000 (at 30-sec period)

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 4 to 5 sec

AVERAGE AMPLITUDES: 0.5 μ (LP instruments)

REMARKS: Adequate information on microseisms is not available. It is expected, however, that disturbances will increase considerably during the monsoon season. Regional earthquakes are the only other natural seismic disturbances anticipated.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 8 km
The nearest highway is 0.2 km
The nearest dam is 12.5 km
The nearest river is 6.4 km

REMARKS: The station will not be disturbed by any of the above.

OTHER INSTRUMENTS IN OPERATION:

Not given

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Copenhagen, Denmark

STATION ABBREVIATION: COP

STATION DIRECTOR:
Dr. Henry Jensen

MAILING ADDRESS:
Geodaetisk Institut
Rigsdagsgaard 7
Kobenhavn K
Danmark

TELEPHONE NUMBER:
Byen 3255

CABLE ADDRESS:
Geodaetinstitut Copenhagen

GEOGRAPHIC COORDINATES:

Latitude: 55° 41' N
Longitude: 12° 26' E

ELEVATION:
13 meters

HISTORY OF STATION:
World Array equipment began operating here on February 16, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
This station is located about 9 km from the center of Copenhagen and about 8 km from the coast. Just west of the station is a residential development. The area is generally flat, with no rivers.

STATION’S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is isolated from buildings and centers of activity. It is about 2 km from the nearest heavily traveled highway. The vault is in one of the semi-underground buildings of the old fortifications of this city.

LOCAL GEOLOGY:
Underlying the station is the Koralkalk of the Danium formation of late Tertiary age. Gentle east dip is thought to be present for all formations.
MAP OF DENMARK'S PRE-QUATERNARY ERA
(Compiled by Theodor Sorgenfrei, 1939)
STATION AND PIER CONSTRUCTION

PIERS:

This vault is rather unique in construction. The concrete walls, roof, and floor are one meter or more thick, and the building, for the most part, is underground. The floor of the building rests on the Koralalk, a chalk of the Danium formation. The floor acts as one large pier with smaller piers for the seismometers and galvanometers built up. These are constructed of brick, have a concrete surface, and are not isolated from the floor.

The cables pass between rooms through the door facings because of the impossibility of drilling through the thick walls. One hole was drilled in the wall between the LP seismometers and the recording room to pass the cable directly between them.

VAULT TEMPERATURE AND HUMIDITY:

There are no temperature control devices for the vault. The structure is well insulated by thick concrete walls and earth. The yearly temperature for the old station varies between 5.2°C and 10.9°C. Since the standardized station is of almost identical construction, similar variations are expected. The relative humidity is maintained at 50%.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS: None of the systems could operate at increased magnification.

SP Z: 12500
SP N-S: 12500
SP E-W: 12500
LP Z: 1500
LP N-S: 1500
LP E-W: 1500

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 5 sec

AVERAGE AMPLITUDES: 0.86 μ

REMARKS: There are seasonal amplitude fluctuations. They are greatest in January and February and smallest in June and July. There are no other natural seismic disturbances here.
VAULT
CONSOLE ROOM
MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:
  The nearest railroad is 2.25 km
  The nearest highway is 1.75 km
  The nearest dam is 2.5 km

REMARKS: There are some local blasts at a distance of about 20 km. Blasts of 70 kg or more are recorded.

OTHER INSTRUMENTS IN OPERATION:

<table>
<thead>
<tr>
<th>Seismometer Type</th>
<th>Period</th>
<th>Galvo. Type</th>
<th>Period</th>
<th>System Magnification (approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galitzin-Wilip</td>
<td>12.5</td>
<td>Hartman-Braun</td>
<td>12.5</td>
<td>1000</td>
</tr>
<tr>
<td>(Z, N, E)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benioff (Z)</td>
<td>1</td>
<td>Hartman-Braun</td>
<td>0.25</td>
<td>30000</td>
</tr>
<tr>
<td>Wiechert</td>
<td>8.5</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>1000 kg H</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wiechert</td>
<td>6</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>1300 kg Z</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RESEARCH PROJECTS IN PROGRESS:

(1) The determination of microseism directions
(2) The study of the discrepancies between short- and long-period verticals in compressional and dilational waves.
(3) Refraction profiles of Denmark are planned for the near future.
STATION FACILITIES

STATION: Corvallis, Oregon

STATION DIRECTOR:
Dr. Joseph W. Berg

MAILING ADDRESS:
Dept. of Oceanography
Oregon State University
Corvallis, Oregon

STATION ABBREVIATION: COR

TELEPHONE NUMBER:
Plaza 2-4211
Ext. 1540
(Area Code 503)

CABLE ADDRESS:
Same as mailing address

GEOGRAPHIC COORDINATES:
Latitude: 44° 35' 08" N
Longitude: 123° 18' 11" W

ELEVATION:
121.5 meters

HISTORY OF STATION:
Dr. Vinyard, professor of physics, operated the seismograph station for ten years until
the installation of the World Array equipment on August 1, 1962, when Dr. Joseph Berg assumed
the directorship.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is located about 4.8 km outside the city of Corvallis. The Willamette River
runs through Corvallis and is also about 4.8 km from the station. The Coast Range of mountains
is approximately 40 km west of the station and follows the coast, moving generally north to south.
These mountains are between three and four thousand feet high.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is in a pasture, isolated from any centers of activity. The nearest road is ap-
proximately 0.4 km from the station and has very light traffic. The nearest buildings, a farm
house and a barn, are about one hundred yards away.

LOCAL GEOLOGY:
The surface consists of basaltic deposits, as does most of Oregon. There are a number of
faults in the area, since mountains are near the station. One of these faults, about 1.6 km to
the west, is believed by some geologists to be active.
STATION AND PIER CONSTRUCTION

PIERS:

The piers are made of reinforced concrete and are isolated from the floor. They extend about 8 feet below the surface and are attached to a weathered layer. The depth to the bedrock is not determined at the station site.

VAULT TEMPERATURE AND HUMIDITY:

There are no heaters or air conditioners in the building. Daily temperature fluctuations are not very wide, and the yearly temperature varies only 5.2°C to 10.9°C. It rains quite a bit during the winter months, and humidity may become a problem.
CROSS SECTION OF PIER, CORVALLIS, OREGON

First Weathered Layer

Concrete Pier

Concrete Floor

Weather Stripping

2 feet
STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

- SP Z: 50000
- SP N-S: 50000
- SP E-W: 50000
- LP Z: 1500
- LP N-S: 1500
- LP E-W: 1500

The LP Z could possibly operate at increased magnification.

BACKGROUND AND NOISE:

- PERIODS OF PREDOMINANT MICROSEISMS: 6 sec
- AVERAGE AMPLITUDES: not given
- REMARKS: Microseismic activity increases during the winter months. It also increases when Pacific storms are in the area. There seem to be no other natural seismic disturbances.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

- The nearest railroad is 4.8 km
- The nearest highway is 0.4 km
- The nearest dam is 60 km
- The nearest river is 4.8 km

REMARKS: The only man-made noise that has been correlated with the records is that of trains coming in and out of Corvallis.

OTHER INSTRUMENTS IN OPERATION:

None

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Charters Towers, Australia

STATION DIRECTOR:
Dr. John P. Webb

STATION ABBREVIATION: CTA

MAILING ADDRESS:
Seismological Station
Univ. of Queensland
Brisbane, Queensland, Australia

TELEPHONE NUMBER:
72021
Ext. 676 Brisbane
339 Charters Towers

CABLE ADDRESS:
University Brisbane

GEOGRAPHIC COORDINATES:
Latitude: 20° 05' 18'' S
Longitude: 146° 15' 16'' E

ELEVATION:
352 meters

HISTORY OF STATION:
Seismic recording started at this location on September 15, 1957. The station was built for IGY. Equipment included a 3-component SP Benioff system of seismometers and both long- and short-period galvanometers. World Array equipment began operating here on March 22, 1963. The station director has always been Dr. John P. Webb of the Geology department of the University of Queensland.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is located about 0.8 km from the town of Charters Towers, a small town with little industry or traffic. It is on a peneplain at an elevation of about 300 meters, approximately 128 km inland from the Pacific Ocean. The station lies at the base of Towers Hill, the largest of a few isolated rock residuals (monadnocks). The Burdekin River is 16 km distant.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
There are no large buildings near the vault. A number of small concrete blockhouses are scattered about the area; one is used for the recording room, the rest for storage. The water reservoir for Charters Towers is located on the summit of an adjacent hill about 1000 feet from the vault. There is no machinery at the reservoir. A gravel road with light traffic is about 600 feet away.
TOPOGRAPHY OF CHARTERS TOWERS AREA
LOCAL GEOLOGY:

The seismometers are located 275 feet inside an old gold mine at the base of Towers Hill. Towers Hill is a solid mass of granodiorite, part of a large batholith which intruded a pre-Devonian metamorphic series. No rocks of the metamorphic series are near the vault. A series of igneous dikes have intruded the batholith. Within the granodiorite, two series of faults of different ages developed. These formed the lode channels in which gold was deposited.

STATION AND PIER CONSTRUCTION

PIERS:

The seismometer vault is a cinder-block room 275 feet inside an old gold mine. The floor is concrete. Piers are attached to bedrock and are isolated from the floor. The LP seismometer pier is 3 feet 6 inches by 9 feet. The SP seismometer pier is 3 feet by 8 feet. Pier tops are 1 foot 6 inches above floor level. Bedrock is two feet below floor level. No reinforcing devices have been used in the pier construction.

The station has three other rooms: the recording, developing, and console rooms. The recording room has separate piers for galvanometers and seismometers. Galvanometer piers are isolated from the floor and, for stability, built in a "T" form. Single drum recorders are used for both SP and LP systems. Photographic facilities are excellent.

VAULT TEMPERATURE AND HUMIDITY:

There is no temperature control equipment in the vault since the climate is mild and none is needed. Temperature will not vary more than a few degrees during the year. Temperature will fluctuate considerably in the recording room, 20°F or more. This variation, however, should be gradual and should not upset the instruments.

Humidity is very high (over 90%) in the seismometer vault. Silica gel has been placed inside the LP instruments to retard corrosion. Tunnels of this type are usually quite humid throughout the year. In the recording room humidity is about 75% and some wrinkling of the records occurs. Humidity will be lowest from April to November.
SEISMOGRAPH STATION AT CHARTERS TOWERS, SITE CONTOUR PLAN
CROSS SECTION OF GALVANOMETER PIER
SEISMOMETER VAULT
Pier Height 1 foot 6 inches
CHARTERS TOWERS STATION

RECORDING ROOM

VAULT
STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 100000
SP N-S: 100000
SP E-W: 100000
LP Z: 3000
LP N-S: 3000
LP E-W: 3000

During the dry season, both systems can operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 2 and 8 sec

AVERAGE AMPLITUDES: Extremely variable.

REMARKS: Greatest microseismic activity occurs from November to March. During the dry season amplitudes are small, but, as storms move through the area, amplitudes increase by a factor of five or more. Other natural seismic disturbances are not common.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 0.8 km
The nearest highway is 1.6 km
The nearest dam is 16 km
The nearest river is 16 km

REMARKS: Man-made noise is not a problem here. Charters Towers is a quiet town. Although a railroad is close, it has no effect on the instruments. A gravel road with very light traffic is 500 feet distant, but this also has no effect on the instruments.

OTHER INSTRUMENTS IN OPERATION:

None

RESEARCH PROJECTS IN PROGRESS:

(1) Fault plane studies under the direction of Dr. Webb
(2) Studies concerning the relationship between microseisms and storms at sea
STATION FACILITIES

STATION: Dallas, Texas
STATION DIRECTOR: Dr. Eugene Herrin
STATION ABBREVIATION: DAL

MAILING ADDRESS:
Dallas Seismological Observatory
Southern Methodist University
Dallas 22, Texas

TELEPHONE NUMBER:
214-363-5611 (Ext. 603)

CABLE ADDRESS:
Same as mailing address

GEOGRAPHIC COORDINATES:
Latitude: 32° 50' 46" N
Longitude: 96° 47' 02" W

ELEVATION:
187 meters

HISTORY OF STATION:
The seismological observatory at Southern Methodist University began operations on December 14, 1953. It is operated by the University's Department of Geology with the cooperation of an Advisory Committee of the Dallas Geophysical Society. World Array equipment began operating here on November 30, 1961.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
This station is located about 8 km north of downtown Dallas. The Dallas area consists of prairie and low hills cut by the Trinity River and its tributaries. The maximum relief between the divides and the nearest streams is about 45 meters.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The Dallas station is located in the basement of the Fondren Science Building on the Southern Methodist University campus. Several extremely busy streets are in the immediate area. The Central Expressway is about 0.8 km from the station. Extreme noise comes from this freeway during the rush hours of the morning and afternoon. Two sets of railroad tracks are within 1 km of the station.

LOCAL GEOLOGY:
This station is located on the lower limestone member of the Upper Cretaceous Austin Formation. The station is underlain by about 150 feet of the Austin formation and by an additional 4000 feet of nearly horizontal limestone, sandstone, and shale of Cretaceous age. Highly folded Paleozoic rocks are below the base of the Cretaceous system.
TOPOGRAPHIC MAP OF DALLAS AREA
STATION AND PIER CONSTRUCTION

PIERS:

The pier is constructed of reinforced concrete. It extends 12 feet to the bedrock and an additional 4 feet into the Austin chalk. The pier stands 2 feet above the floor and is isolated from it by an air gap of 1 inch filled with fiber glass. Cables pass between the pier and recording rooms through a conduit in the wall. The console is located on the second floor of the building.

VAULT TEMPERATURE AND HUMIDITY:

Temperature in the Fondren Science Building is thermostatically controlled at all times except weekends. Greatest temperature fluctuations, about 12°F, occur on Monday morning, when heating or cooling units are turned on in the building. Temperatures should range between 68° and 78° F. The instrument rooms are heated and cooled by the surrounding areas and contain no devices for that purpose. Humidity is not excessively high.
STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:
- SP Z: 25000
- SP N-S: 25000
- SP E-W: 25000
- LP Z: 1500
- LP N-S: 1500
- LP E-W: 1500

None of the systems could operate at increased magnification.

BACKGROUND AND NOISE:

- PERIODS OF PREDOMINANT MICROSEISMS: about 7.5 sec
- AVERAGE AMPLITUDES: 2.5 µ

REMARKS: Microseismic activity is greatest during the early fall and winter, though the amplitude of the microseisms is a problem all year. Arrival of cold fronts tends to increase this activity. The station is using a notch filter to eliminate most of the microseismic disturbance.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:
- The nearest railroad is 1 km
- The nearest highway is 0.8 km
- The nearest dam is 8 km
- The nearest river is 8 km

REMARKS: There is some quarry activity in the area; blasts occur at irregular intervals. Railroad and automobile traffic cause minor disturbances.

OTHER INSTRUMENTS IN OPERATION:
- None

RESEARCH PROJECTS IN PROGRESS:
- The University is currently looking for a good location for a new station in the Trans Pecos area of West Texas.
STATION FACILITIES

STATION: Dugway, Utah
STATION DIRECTOR:
Dr. Kenneth L. Cook

STATION ABBREVIATION: DUG
MAILING ADDRESS:
Department of Geophysics
University of Utah
Salt Lake City, Utah

TELEPHONE NUMBER:
University: DA 8-9011 (Ext. 6201)
Area Code: 801
Dugway: EL 9-8681

CABLE ADDRESS:
Same as mailing address

GEOGRAPHIC COORDINATES:
Latitude: 40° 11' 42'' N
Longitude: 112° 48' 48'' W

ELEVATION:
1453.5 meters

HISTORY OF STATION:
World Array equipment began operating here May 9, 1962.

LOCAL GEOGRAPHY:
The vault is located on the west side of Little Granite Mountain.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is in an isolated spot on the Dugway Proving Grounds.

LOCAL GEOLOGY:
The vault is built into solid granite.
STATION AND PIER CONSTRUCTION

PIERS:
Not given.

VAULT TEMPERATURE AND HUMIDITY:
Temperature control is excellent, constant at 62°F. The station has an excellent solar electric heating system, but it cannot be used because it creates a magnetic field which causes the instruments to drift. However, no control is really necessary since the vault is covered with three feet of dirt. Humidity at present is 80% because the vault is new and has not had a chance to dry out. The outside humidity averages around 20%; so the vault should dry out in a few months. Silica-gel will be used until the condition improves.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 400000
SP N-S: 400000
SP E-W: 400000
LP Z: 3000
LP N-S: 3000
LP E-W: 3000

None of the systems can operate at increased magnification.

BACKGROUND AND NOISE:
PERIODS OF PREDOMINANT MICROSEISMS: 1 and 0 sec

AVERAGE AMPLITUDES: Not given

REMARKS: This is a new station; consequently, adequate data concerning background and noise is not available.

MAN-MADE NOISE:
FROM THE SEISMOMETER VAULT:
The nearest railroad is 56 km
The nearest highway is 1.2 km

REMARKS: Kennecott Copper Mine at Bingham Canyon about 96 km NE of the station sets off a large charge of dynamite, between 2200 and 2400 GCT, each day.

OTHER INSTRUMENTS IN OPERATION:
None

RESEARCH PROJECTS IN PROGRESS:
Not given

DUG-3
STATION FACILITIES

STATION: Florissant, Missouri
STATION DIRECTOR:
Rev. Victor J. Blum, S.J.
STATION ABBREVIATION: FLO
MAILING ADDRESS:
St. Louis University
Institute of Technology
3621 Olive St.
St. Louis 8, Missouri

TELEPHONE NUMBER:
JE 5-3300
CABLE ADDRESS:
Same as mailing address

GEOGRAPHIC COORDINATES:
Latitude: 38° 48' 06" N
Longitude: 90° 22' 12" W
ELEVATION:
157.5 meters

HISTORY OF STATION:
World Array equipment began operating here on December 2, 1961.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is located in the small suburban town of Florissant, Missouri, approximately
32 km NW of St. Louis and about 2.4 km south of the Missouri River. The surrounding lands
are essentially flat.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is in an isolated area. The nearest building is about 1700 feet distant and
the closest paved road is about 1500 feet away. A plowed field, adjacent to the station, could
cause noise during plowing. Other farms are located in the general area.

LOCAL GEOLOGY:
The general geologic horizon of the Florissant area is of Pennsylvanian age. The station
itself, however, rests on thick clay of Recent origin, which is apparently in contact with Mis-
sissippian bedrock. Depth to bedrock is about 50 to 60 feet. Some sections of the clay seem to
be Pleistocene lake deposits.
TOPOGRAPHIC MAP SHOWING FLORISSANT SEISMOGRAPH STATION
FLORISSANT QUADRANGLE
ST. LOUIS COUNTY, MO
Data Taken from U.S.G.S.
<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>SERIES</th>
<th>GROUP</th>
<th>FORMATION</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quaternary</td>
<td>Recent</td>
<td></td>
<td>100' of</td>
<td>Loess &amp; Clay</td>
</tr>
<tr>
<td></td>
<td>Pleistocene</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tertiary</td>
<td>Pliocene</td>
<td>Lafayette</td>
<td>30' of</td>
<td>Sand</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pennsylvanian</td>
<td>Des Moines</td>
<td>Pleasanton</td>
<td>SH &amp; LS</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Henrietta</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Meramec</td>
<td>Cherokee</td>
<td>SH</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>St. Louis</td>
<td>200' of</td>
<td>Le</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spergen</td>
<td>LS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Misseissippian</td>
<td></td>
<td>Warsaw</td>
<td>SH</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Keokok-</td>
<td>180' of</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Burunton</td>
<td>LS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reed &amp;</td>
<td>35' of</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Springs</td>
<td>LS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chateau</td>
<td>40' of</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sulphur</td>
<td>20' of</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Springs</td>
<td>SS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silurian</td>
<td>Alexandrian</td>
<td>Edgewood</td>
<td>135' of</td>
<td>Dolomite</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cincinnatian</td>
<td></td>
<td>Richmond</td>
<td>SH</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maquoketa</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trenton</td>
<td>Kimmswick</td>
<td>LS</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mohawkian</td>
<td>Black River</td>
<td>Decorah</td>
<td>SH</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plattin</td>
<td>LS</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ordovician</td>
<td>Buffalo River</td>
<td>Joachim</td>
<td>Dolomite</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>St. Peter</td>
<td>SS</td>
<td></td>
</tr>
<tr>
<td>Cambrian</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Approximate Depth from Surface to Pre-Cambrian = 2500 feet.)

GEOLOGIC SEQUENCE WITH SOME APPROXIMATE THICKNESSES NEAR FLORISSANT SEISMOGRAPH STATION
(N.B. Pennsylvanian is Missing At Station.)
STATION AND PIER CONSTRUCTION

PIERS:
The vault is a separate structure underground, reached by a stairway. It is made of concrete and is divided into three rooms. The vault's ceiling is 10 feet below the ground surface. Piers are built directly into the floor. Cables pass from the console room to the seismometer room through a hole in the wall. Galvanometers and paper recorders are mounted in double-deck fashion.

VAULT TEMPERATURE AND HUMIDITY:
No heating or air conditioning equipment is installed in the vault. Seasonal temperature variation in the vault is from 54° to 66°F. Lowest temperatures occur in January and February; highest in July and August. Humidity is controlled by a dehumidifier in the photographic processing room and is fairly constant at about 40%. The University intends to install a second dehumidifier in the vault to aid in keeping the entire vault at a constant humidity.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>50000</td>
</tr>
<tr>
<td>SP N-S</td>
<td>12500</td>
</tr>
<tr>
<td>SP E-W</td>
<td>12500</td>
</tr>
<tr>
<td>LP Z</td>
<td>1500</td>
</tr>
<tr>
<td>LP N-S</td>
<td>1500</td>
</tr>
<tr>
<td>LP E-W</td>
<td>1500</td>
</tr>
</tbody>
</table>

None of the systems can operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 0, 0.6, and 0.3 sec

AVERAGE AMPLITUDES: up to 3 μ

REMARKS: Microseismic activity at the Florissant station is lowest in July and August, then increases to a maximum in February. Studies have shown that the periods of the microseisms in the summer months ranged from 3.9 to 4.1 seconds; in the winter from 4.0 to 5.5 seconds. These microseisms are linked with storm activity in the Caribbean and the Atlantic. Other natural seismic disturbances are occasional low-magnitude local earthquakes east and west of the station.
SAINT LOUIS UNIVERSITY SEISMOGRAPH VAULT AT
FLORISSANT, MISSOURI
All Piers 2'2" High

5 feet
SAINT LOUIS UNIVERSITY SEISMOGRAPH VAULT AT FLORISSANT, MISSOURI: SEISMOMETER AND RECORDING ROOM
All Piers 2'2" High

4 feet
SAINT LOUIS UNIVERSITY SEISMOGRAPH VAULT AT
FLORISSANT, MISSOURI: CONTROL AND BATTERY ROOM
SAINT LOUIS UNIVERSITY SEISMOGRAPH VAULT AT FLORISSANT, MISSOURI: PHOTOGRAPHIC PROCESSING ROOM

2 feet
DOUBLE-DECK RECORDER PIER

MAN-MADE NOISE:

FROM THE SEISMMOMETER VAULT:

The nearest railroad is 4 km
The nearest highway is 2.4 km
The nearest river is 2.4 km

REMARKS: St. Louis is in an area where limestone and dolomite bedrock is frequently exposed. As a result there are a large number of quarries where blasting frequently occurs. In addition, across the Mississippi River in Illinois, about 80 to 120 km distant, a number of coal strip mines are located. Large blasts frequently occur in these mines, particularly in the early morning.

There is a great amount of high-frequency horizontal noise in the area. This noise has been noted by the Seismology Department of St. Louis University, but its exact source has not been determined. As a result, the magnification of the short-period instruments is very low.

OTHER INSTRUMENTS IN OPERATION:

<table>
<thead>
<tr>
<th>Sels. Type</th>
<th>Period</th>
<th>Galvo. Type</th>
<th>Period</th>
<th>System Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galitzin-Wilip Z</td>
<td>12</td>
<td>Hartman &amp; Braun</td>
<td>12</td>
<td>725</td>
</tr>
<tr>
<td>Galitzin-Wilip N-S</td>
<td>12</td>
<td>Hartman &amp; Braun</td>
<td>12</td>
<td>725</td>
</tr>
<tr>
<td>Galitzin-Wilip E-W</td>
<td>12</td>
<td>Hartman &amp; Braun</td>
<td>12</td>
<td>885</td>
</tr>
</tbody>
</table>

RESEARCH PROJECTS IN PROGRESS:
None
STATION FACILITIES

STATION: Godhavn, Greenland

STATION DIRECTORS:
Dr. Henry Jensen
Mr. Axel Hansen

TELEPHONE NUMBER:
None

GEOGRAPHIC COORDINATES:
Latitude: 69° 15' N
Longitude: 53° 32' W

HISTORY OF STATION:
World Array equipment began operating at this station on November 2, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is located about 800 meters NE of the main section of the village of Godhavn on the southern part of Disko Island. It is about 300 meters from the bay and about 250 meters from the only road in the area, which has very light traffic. About 3 km north of the station are mountains with an elevation of about 700 meters. There are no large rivers nearby, only small streams from the mountains to the bay.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is very isolated. The nearest building, a two-story dwelling, is approximately 200 meters south. Antenna towers for the local radio station are one km to the south.

LOCAL GEOLOGY:
The station itself is attached to gneiss beds of outcropped rock. Gneiss is predominant in this vicinity, with some scattered granite. At higher elevations the stratigraphy consists of basalts sandwiched between volcanic ash. The gneiss on the surface here seems exceptional, since most of the outcrops in southern Greenland are granite.

MAILING ADDRESS:
Seismological Station
Godhavn (Disko), Greenland

CABLE ADDRESS:
Seismological Station
Godhavn, Greenland

ELEVATION:
23 meters
STATION AND PIER CONSTRUCTION

PIERS:

Piers are of solid concrete, attached to gneiss rock as is the building. The piers also have an insulation of cork along the sides, between the pier proper and outer shell of concrete. Also for insulation, the top of the piers are covered by one-inch styrofoam with holes for the feet of the seismometers.

VAULT TEMPERATURE AND HUMIDITY:

Heat is controlled by thermostats in each room. All rooms are heated with steam radiators, which are very small and are placed along the walls near the ceiling. The heat, of course, has been turned off in the seismometer rooms where the steam pipes have also been insulated. The building is very well insulated, and the daily temperature appears relatively stable. However, there will be large fluctuations from one season to another, though these are not expected to affect the operation of instruments. Since this is a new building, there is no way of knowing what the actual differences in temperature may be in the instrument rooms. The instrument rooms contain very little moisture because of the dry climate.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

- SP Z: 12500
- SP N-S: 12500
- SP E-W: 12500
- LP Z: 750
- LP N-S: 750
- LP E-W: 750

Possibly all systems could operate at increased magnification during the summer months.

BACKGROUND AND NOISE:

- PERIODS OF PREDOMINANT MICROSEISMS: 5 or 6 sec
- AVERAGE AMPLITUDE: not given

REMARKS: As this is a new station, adequate data concerning background and noise are not available. The predominant disturbance here is the movement caused by breaking of ice on the cap. Whether the disturbances will be recorded is not known at this time.
CROSS-SECTION OF LONG-PERIOD PIER AT GODHAVN

MAN-MADE NOISE:

There are no railroads, highways, dams, or rivers in this area.

OTHER INSTRUMENTS IN OPERATION:

(1) LaCour, Edelmann, and Ruska magnetic instruments
(2) Carnegie Institute cosmic ray meter

RESEARCH PROJECTS IN PROGRESS:
Not given
STATION FACILITIES

STATION: Georgetown University
STATION DIRECTOR: Rev. Frederick Sohon, S. J.

STATION ABBREVIATION: CEO
MAILING ADDRESS: Georgetown University
Washington 7, D. C.

TELEPHONE NUMBER: FE 7-3300
CABLE ADDRESS: Same as mailing address

GEOGRAPHIC COORDINATES:
Latitude: 38° 54' N
Longitude: 77° 4' W

ELEVATION: 41.7 meters

HISTORY OF STATION:
World Array equipment began operating here on December 7, 1961.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
Georgetown is an old residential district of west Washington with cobblestone streets. It lies at the head of tidewater above the north bank of the Potomac River. It is on the eastern edge of the Piedmont plateau; the Fall Line runs through the District of Columbia just east of Georgetown. The station is 0.8 km from main thoroughfares, 8 km from the National Airport and principal railroad lines, 48 km from Chesapeake Bay, and 176 km from the Atlantic Ocean.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located on the University Campus in the metropolitan area. Equipment is situated in the basement of the Physics Building.

LOCAL GEOLOGY:
Precambrian bedrock of granite, gneiss, schist, and diorite underlie the District of Columbia. The bedrock is found at the surface in west Washington but deeply weathered in most places. A large body of diorite underlies Georgetown. The soil is a brownish-red, micaceous sand. Seismometer piers are on weathered diorite 10-40 feet above the solid base.
GEORGETOWN UNIVERSITY AREA
STATION AND PIER CONSTRUCTION

PIERS:

The signal cables lie on the floor of the chamber, against the north walls; they pass through the light-tight recording room wall at the floor, go immediately up the wall, and are distributed in the recording area from overhead, as shown. The horizontals are on the large pier and the verticals are on the small pier in order to accommodate the seismometer sizes. The vault heater line passes near the console cabling, but is otherwise isolated. The recording-power and timing-pulse lines are passed overhead into the seismometer room and from there to the recording area. Paralleling is done on a Jones-Barrier terminal strip located over the recording area entrance.

The six-foot reinforced concrete piers are isolated from the building at their base and sit on decayed diorite. The top is at floor level. The light-tight access to the recording area was added for temperature isolation. To further isolate the temperature of the area, the seismometer vault was constructed with a false ceiling and an electric heater was installed.

VAULT TEMPERATURE AND HUMIDITY:

There is electrical temperature control in the vault. Vault temperature at present is set at 65°F and ranges from 50°F to 95°F: 50°F from late November until March and 95°F in June and July. (The above range was noted before any of the attempts at vault temperature isolation were completed. The range should get smaller, but the necessity of readjusting the LP Z temperature compensator will remain.) The console room has steam pipes passing through it, and the temperature might rise as high as 100°F during very cold weather. The humidity is high (70 to 80%), but by leaving the lights burning in the seismometer vault it will be reduced. The humidity is highest from February to April.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>25000</td>
</tr>
<tr>
<td>SP N-S</td>
<td>25000</td>
</tr>
<tr>
<td>SP E-W</td>
<td>25000</td>
</tr>
<tr>
<td>LP Z</td>
<td>750</td>
</tr>
<tr>
<td>LP N-S</td>
<td>750</td>
</tr>
<tr>
<td>LP E-W</td>
<td>750</td>
</tr>
</tbody>
</table>

The LP Z could operate at increased magnification.
BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 6 sec
AVERAGE AMPLITUDES: 1.33 μ

REMARKS: The greatest microseisms occur during winter months; the least during summer. Microseismic activity is quite pronounced when cold fronts pass over Washington, D.C. It is extraordinarily great when hurricanes pass up the Atlantic coast. Continuous microseisms have limited the degree of magnification used in the Georgetown seismographs in past years. Occasional local earthquakes with epicenters in the Appalachian Mountain range have been observed on the Georgetown records.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:
The nearest railroad (service road) is 0.8 km
The nearest highway is 150 yards
The nearest river is 250 yards

REMARKS: This station is located in a metropolitan area, and the noise from car traffic and trolley lines is pronounced except from midnight until 6:00 a.m.

OTHER INSTRUMENTS IN OPERATION:
None

RESEARCH PROJECTS IN PROGRESS:
None
STATION FACILITIES

STATION: Golden, Colorado
STATION ABBREVIATION: GOL

STATION DIRECTOR:
John C. Hollister
MAILING ADDRESS:
Colorado School of Mines
Golden, Colorado

TELEPHONE NUMBER:
Hollister 2793381
(Cable address: Same as mailing address)
(Seismograph station: 277-0369)

GEOGRAPHIC COORDINATES:
Latitude: 39° 42' 1" N
Longitude: 105° 22' 16" W
ELEVATION:
2324 meters

HISTORY OF STATION:
World Array equipment began operating here on December 21, 1961.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
See topographic map.

STATION’S RELATION TO OTHER BUILDINGS AND MAN-MADE STRUCTURES:
The station is relatively isolated, 1.2 km from the nearest town, Bergen Park. A road is about 75 yards from the recording building, but it is seldom used. The vault is 500 feet further away from this road, and no evidence of vehicular disturbance has been noted.

LOCAL GEOLOGY:
The station lies on Precambrian rock (Idaho Springs formation). In the immediate vicinity, the metamorphic rocks consist of quartz-plagioclase-biotite schists, plagioclase hornblende schists, potash feldspar-quartz gneisses, hornblende-andesite gneisses, and dense granitized gneisses. The igneous rocks are granite pegmatites and metamorphosed diorite. Local metamorphic rocks are predominantly layered paragneisses which have been greatly folded, and are disrupted by minor faults and joints. The pegmatites follow some of these fractures and are massive bodies from 5 to 25 feet wide and up to 200 feet long. At present the terrain is a Precambrian block which shows no evidence of movement after the Tertiary period.
STATION AND PIER CONSTRUCTION

PIERS:

The vault is located approximately 500 feet from the control house. It was originally a feldspar mine. Walls are sealed with granite (1 inch to 6 inches); the roof is about 8 feet high. Overburden is from 10 to 15 feet. The entrance tunnel is 40 feet long. There is a single pier (3 1/2 feet × 13 1/2 feet × 1 1/2 feet) anchored to a pegmatite dike by eight shafts of reinforcing steel. The floor is separated from the pier by 2 inches of tar.

The control house basement recording room is 10 feet 2 inches by 20 feet. Outside walls are 8-inch concrete blocks; inside walls are 6-inch concrete blocks. The floor is a 4-inch concrete slab. There are no heating vents in this room. There are two concrete block piers for the recording drums. The SP pier is 10 1/2 feet × 2 feet × 2 feet. The LP pier is 6 1/2 feet × 2 feet × 2 feet and sits directly on the floor. Galvanometer piers are: (LP) 2 feet × 1 foot × 6 1/2 feet; (SP) 2 feet × 1 foot × 10 1/2 feet. Both galvanometer piers extend through the floor 6 inches to the bedrock and are anchored by steel reinforcing shafts. They are separated from the floor by 2 inches of tar. The galvanometers are not bolted to the piers.

VAULT TEMPERATURE AND HUMIDITY:

A central heating plant is located in the recording building, automatically controlled by a thermostat. Heat is directed into the darkroom and console room, but not into the recording room. Air conditioning is not present and is probably not needed. The temperature extremes are not known. Outside temperatures will probably vary from as high as 100°F to below 0°F. The recording building temperature is regulated at approximately 70°F. Temperature inside the vault remains almost constant at 55°F.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>100000</td>
</tr>
<tr>
<td>SP N-S</td>
<td>100000</td>
</tr>
<tr>
<td>SP E-W</td>
<td>100000</td>
</tr>
<tr>
<td>LP Z</td>
<td>1500</td>
</tr>
<tr>
<td>LP N-S</td>
<td>1500</td>
</tr>
<tr>
<td>LP E-W</td>
<td>1500</td>
</tr>
</tbody>
</table>

None of the systems can operate at increased magnification.
BACKGROUND AND NOISE:

**PERIODS OF PREDOMINANT MICROSEISMS:** 3 to 7 sec (occasionally 1 to 2 seconds)

**AVERAGE AMPLITUDES:** Not given

**REMARKS:** Adequate data on background and noise at this station are not available.

MAN-MADE NOISE:

**FROM THE SEISMOMETER VAULT:**
- The nearest railroad is 21.6 km
- The nearest highway is 2 km
- The nearest dam is 3.2 km
- The nearest river is 3.2 km

**REMARKS:** This station is extremely isolated. Most of the noted noise sources are several km away. The nearest heavily traveled road is US 40, 2 km away. No construction that would require blasting is under way at present.

OTHER INSTRUMENTS IN OPERATION:

None

RESEARCH PROJECTS IN PROGRESS:

Attempts are being made to correlate atmospheric pressure changes with observed long-period interference (4-9 minutes).
STATION FACILITIES

STATION: Goldstone, California (Cal. Tech)  
STATION ABBREVIATION: GSC

STATION DIRECTOR: Francis E. Lehrner

MAILING ADDRESS: 220 San Rafael Ave.  
Pasadena, California

TELEPHONE NUMBER: Clinton 6-6854 (Ext. 7-231 (Goldstone))  
CABLE ADDRESS: Teletype (TWX)  
213-449-1354 (Goldstone)

GEOGRAPHIC COORDINATES:  
Latitude: 35.120 N  
Longitude: 1170 W

ELEVATION: 989.49 meters

HISTORY OF STATION:  

STATION ENVIRONMENT

LOCAL GEOGRAPHY:  
The station is located in the Mojave desert. The immediate area is hilly.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:  
The station is located at the Goldstone Tracking Station on the grounds of Fort Irwin Desert Training Center, about 72 km north of Barstow, California. The tracking site consists of seven support and maintenance buildings and an 85-foot parabolic antenna. The vault is situated on the side of a hill overlooking the tracking station, approximately 300 feet from the nearest building.

LOCAL GEOLOGY:  
Recent alluvial deposits overlie eroded early volcanics of Tertiary and Quaternary age. These are primarily basalts, although some thin layers of pumiceous tuff and agglomerate are present. The older basement complex consists of igneous, meta-igneous, and meta-sedimentary rocks.
TOPOGRAPHIC MAP OF GOLDSTONE, CALIFORNIA AREA. Grid spacing is approximately one mile.
STATION AND PIER CONSTRUCTION

PIERS:
The seismometers are floor mounted. Long-period instruments are on a slab which was poured in a short tunnel in the side of the hill. This slab has projections down into channels cut in the bedrock. It is not isolated from the building which is connected to the bedrock in the same manner. This bedrock is granite.

VAULT TEMPERATURE AND HUMIDITY:
Temperature is controlled by a heat pump on the roof of the station which both heats and cools the building and maintains fairly constant temperature. There is no humidity problem at this station. Humidity is steady at 30% except on the infrequent occasions when it rains.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>200000</td>
</tr>
<tr>
<td>SP N-S</td>
<td>200000</td>
</tr>
<tr>
<td>SP E-W</td>
<td>200000</td>
</tr>
<tr>
<td>LP Z</td>
<td>3000</td>
</tr>
<tr>
<td>LP N-S</td>
<td>3000</td>
</tr>
<tr>
<td>LP E-W</td>
<td>3000</td>
</tr>
</tbody>
</table>

The SP Z could operate at increased magnification.

BACKGROUND AND NOISE:
This is a new station, and no information on background and noise is available.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:
The nearest railroad is 72 km
The nearest highway is 72 km (200 yards to station road)
The nearest river is 72 km

REMARKS: There are also seismic signals from the Nevada Test Site.

OTHER INSTRUMENTS IN OPERATION:
One Benioff vertical seismograph with a Geotech Heliograph visible recorder

RESEARCH PROJECTS IN PROGRESS:
None

GSC-4
STATION FACILITIES

STATION: Hallett, Antarctica

STATION DIRECTOR:
   Dr. F. F. Evison

STATION ABBREVIATION: HLL

MAILING ADDRESS:
   Dr. F. F. Evison
   D. S. I. R.
   Superintendent, Seismological
   Observatory
   Box 8005
   Wellington, New Zealand

CABLE ADDRESS:
   Not given

TELEPHONE NUMBER:
   USARP Rep. Christchurch
   31729 and 33059

GEOGRAPHIC COORDINATES:
   Latitude: 72° 18' 50" S
   Longitude: 176° 13' 00" E

ELEVATION:
   1.5 meters

HISTORY OF STATION:
   Seismic recording began early in 1956 when the station was established for IGY. World
   Array equipment began operating on March 8, 1963.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
   The station is situated on a small spit along the west coast of the Ross Sea. The station site
   is a penguin rookery and 160,000 birds are present in the summer. A 1000-foot-high ridge, which
   runs north to cast, is 0.8 km from the station. It has a large ice fall and several minor glaciers
   facing the station. The sea is frozen over except from January to March. During these three
   months, waves and iceberg movements occur. Winds are common at Hallett, and reach a
   velocity of 100 knots at times. Windy periods last two or three days.

STATION’S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
   Base buildings are located 1000 feet from the vault. The tallest structure nearby is the
   20-foot-high auroral tower. Other buildings are 8 feet high. There are power poles 32 feet
   high, and one of these is near the recording room. Two D-4 tractors and two trucks operate
   in the area, but do not normally go near the vault which is 200 feet from the sea and 100 feet
   from a 25-foot-high VLF tower.

HLL-1
LOCAL GEOLOGY:

The spit of land on which the station is located is a hook-shaped deposit of beach and moraine material and penguin guano. Maximum height ASL is about 15 feet. The spit is normally hard permafrost. The mixture of guano and rock thaws to approximately 3 feet in summer. The adjacent ridge is composed of basalt. The sea bottom slopes off sharply: depth is 90 fathoms at 0.1 km from the shore and goes to 250 fathoms a little further out. The seismometer vault is situated on clean beach deposit; no layer of guano was uncovered during excavation.

STATION AND PIER CONSTRUCTION

PIERS:

The instruments are set directly on the concrete floor, which is 6 inches thick and rests on clean gravel permafrost (glacial and beach deposits). All cement and aggregate was mixed directly on the floor. An air gap separates the walls from the floor. The wall lightly touches the slab at the rear of center.

The galvanometer pier is 2 feet × 6 feet × 4 feet and stands 2 1/2 feet above the floor. It is separated from the floor, but the gasket is tightly compressed. When the outside door is slammed, the SP galvanometers will oscillate. Recorders are on wooden tables.

VAULT TEMPERATURE AND HUMIDITY:

The heat in the console room is thermostatically controlled. There is no environmental control in the seismometer vault or recording room. Seasonal temperature variations range from -50°F to 45°F. There is a daily temperature fluctuation in the vault only in summer. Humidity, highest in summer when melt water is present, is not expected to be a problem here.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 6250
SP N-S: 6250
SP E-W: 6250
LP Z: 750
LP N-S: 750
LP E-W: 750

All systems should be able to operate at considerably higher magnification during the nine months of freeze over.

HLL-3
GENERAL SKETCH OF HALLETT INSTRUMENT ROOMS
BACKGROUND AND NOISE:

REMARKS: Periods and amplitudes of predominant microseisms are not known as yet. Highest microseismic activity occurs from December to March, due to the summer winds, wave action, and ice movements (glaciers and icebergs).

MAN-MADE NOISE:

REMARKS: There are no railroads, highways, dams, or rivers in this area. Possible man-made sources of noise are two D-4 tractors and two trucks, and station generators 1300 feet from the vault.

OTHER INSTRUMENTS IN OPERATION:

(1) 3 Columbia seismographs ($T_o = 15$ sec; $T_g = 75$ sec)
(2) 1 SP Z Willmore ($T_o = 1$ sec)
   Timsley galvanometer ($T_g = 2$ sec)

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Helwan, Egypt

STATION DIRECTOR:
Dr. Abdel Hamid Samaha

STATION ABBREVIATION: HLW

MAILING ADDRESS:
Helwan Observatory
Helwan, Cairo, Egypt
U. A. R.

TELEPHONE NUMBER:
38645

CABLE ADDRESS:
Same as mailing address

GEOGRAPHIC COORDINATES:
Latitude: 29° 51' 30" N
Longitude: 31° 20' 30" E

ELEVATION:
115.6 meters

HISTORY OF STATION:
The observatory was first located in Boalague, Egypt (1839 to 1868). It was transferred to Abbassiah in 1868. In 1903 the observatory was transferred to Helwan and the seismology section started with two Milne instruments. In 1921 an E-W Milne-Shaw seismograph was installed to replace the two Milne instruments. In 1937 a new seismometer building was constructed. The seismometer vault now in use is three meters below ground level. The observatory also has meteorological, magnetic, and astronomic sections. Some of the past station directors are:

(1) H. Knox Shaw (1913-1924)
(2) P. A. Curry (1924-1934)
(3) M. R. Madwar (1934-1953)
(4) Dr. Abdel Hamid Samaha (1953- )

World Array equipment began operating here June 18, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The Helwan Observatory is located in an isolated, slightly elevated area on the eastern edge of Helwan, Cairo, Egypt. It is 5 km east of the Nile River. A limestone quarry is about 700 meters away. A factory is 1.5 km away. Elevated land is east of the station, but there are no mountains.
STATION’S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:

The station is at a somewhat higher elevation than Helwan. There are several structures nearby, the largest being a two-story office building about 75 feet from the seismometer vault.

LOCAL GEOLOGY:

The formations at the observatory are argillaceous limestone of Cretaceous age, which dips 6° to 8° north—NW.

STATION AND PIER CONSTRUCTION

PIERS:

The seismometer piers are made of concrete. The tops and sides have a smoothed over finish of cement; in some places this has separated from the pier. Holes have been chiseled through this cement finish and into the concrete. Brass plugs for the feet of the SP seismometers and glass foot plates for the LP seismometers were secured in these holes with plaster of Paris.

VAULT TEMPERATURE AND HUMIDITY:

There is no environmental control. Seasonal temperature fluctuations are as follows:

(1) Seismometer Room:
   (a) July and August 28°C
   (b) January and February 22°C

(2) Recording Rooms:
   (a) July and August 30°C
   (b) January and February 20°C

All rooms have been very dry. However, with the complete sealing of the air vents which ventilated the space surrounding the seismometer vault, the humidity appears to have increased.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 50000
SP N-S: 50000
SP E-W: 50000
LP Z: 3000
LP N-S: 3000
LP E-W: 3000

Possibly the long-period system could operate at increased magnification.
HELWAN OBSERVATORY SEISMOLOGICAL STATION
Dimensions in Meters
CROSS-SECTION OF SEISMOLOGICAL STATION
Dimensions in Meters
SEISMOMETER PIER
HELWAN STATION
SEISMMETER ROOM
BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: Not given

AVERAGE AMPLITUDES: Not given

REMARKS: No study of the microseismic activity has been conducted. There is very little natural seismic disturbance at this location.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 1.5 km
The nearest highway is 2.5 km
The nearest dam is 320 km
The nearest river is 5 km

REMARKS: Located near the seismometer building are a water reservoir (300 meters), a power plant (4.5 km), a factory (1.5 km), and a limestone quarry (700 meters). There are several factories being built in this area; if any are constructed much closer, the station magnification may be cut considerably. There is not much activity in the limestone quarry, but a small blast is set off occasionally and is noticeable on the seismograms.

OTHER INSTRUMENTS IN OPERATION:

Galitzin-Wilip Z

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Honiara, Guadalcanal

STATION DIRECTOR:
Mr. John C. Grover

STATION ABBREVIATION: HNR

MAILING ADDRESS:
Chief Geologist
Honiara Seismological Survey Dept.
Box 62
Honiara, Guadalcanal, B.S.I.P.

TELEPHONE NUMBER:
None

CABLE ADDRESS:
Not given

GEOGRAPHIC COORDINATES:
Latitude: 9° 25' 53.86" S
Longitude: 159° 56' 47.64" W

ELEVATION:
84.817 meters above mean high water mark

HISTORY OF STATION:
World Array equipment began operating here on February 7, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is on a coral reef 2.4 km from the sea and about 1.6 km south of the town. Terraces extend to the south, increasing in elevation to 1600 feet. Further south is a deep gorge and the granodiorite and volcanic core of the island. The Mataniko River is about 1.6 km to the east. Deeply cut watercourses nearby are usually dry. There is a power station on the alluvial flats of the town, 0.8 to 1.2 km away.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is isolated from any main roads or business activity in Honiara. The vault is 350 feet from the Geological Survey Office and is buried on the inner (south) side of the reef to shield it from the NW trade winds.

LOCAL GEOLOGY:
The outpost vault is on loosely consolidated silty sandstone. It is a typical reef sludge with massive hard limestone lenses and recent foraminifera and comminuted shell fragments. The rock is feldspar (90%), altered and unaltered, with minor amounts of quartz (angular), biotite, hornblende, iron oxides, and epidote. Most grains are iron-stained. The rock is a reworked, sorted component of erosional detritus from a lava terrain, and is underlain by massive white Miocene limestone.
STATION AND PIER CONSTRUCTION

PIERS:

The seismometer vault is of reinforced concrete and is located about 350 feet from the recorder room, which is in the Geological Survey Building. Piers are of reinforced concrete, isolated from the floor, and extend one foot above floor level and about 18 inches below it; they rest on the loosely consolidated sandstone. The galvanometer piers are constructed of reinforced concrete and are isolated from the floor. The cabling from the galvanometers and the calibration lines are run underground, in a 1 1/2-inch waterpipe. The console is in a small room adjacent to the recorder room; its cabling is run overhead into the recording area. Cabling in the seismometer vault and the recorder room is placed on the floor adjacent to the piers.

VAULT TEMPERATURE AND HUMIDITY:

There is no temperature control. Temperature is exceptionally stable since the recording room is underground and sealed. The air-conditioned recording area is kept at 72°F and 70% humidity. Outside temperature averages 85°F all year; 3°F variations in the seismometer vault are possible. Humidity in the seismometer vault ranges from 80 to 100%.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

- SP Z: 125000
- SP N-S: 125000
- SP E-W: 125000
- LP Z: 1500
- LP N-S: 1500
- LP E-W: 1500

SP systems could operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 1 sec

AVERAGE AMPLITUDES: Not given

REMARKS: Though no definitive microseismic information has been compiled, amplitude fluctuations are larger in the first quarter of the year. During the rainy season, wave action is greater, causing microseisms of larger amplitude. Regionally there are active volcanoes: a submarine volcano is about 192 km west of Honiara. Occasional local earthquakes occur on the island of Guadalcanal or nearby islands.
MAN-MADE NOISE:
There are no railroads, highways, or dams in this area. A river is 4 km from the station.

OTHER INSTRUMENTS IN OPERATION:
A three-component Willmore system (seismometer period = 1 sec)

RESEARCH PROJECTS IN PROGRESS:
An attempt will be made to provide definite information concerning the nature of volcanic seismic phenomena as generated by the quiescent volcano Savo (32 km from the station). Because of the great gravity anomaly in the Guadalcanal region, an attempt to correlate gravity anomalies with epicenters will be made. Furthermore, installation of World Array equipment enables portable equipment previously used at the station to be located on other nearby islands to form a tripartite arrangement. Lastly, travel-time curves will be developed for this region and compared to the 1939 Jeffreys-Bullen tables.
STATION FACILITIES

STATION: Istanbul, Turkey

STATION DIRECTOR:
Dr. Kazim Ergin

STATION ABBREVIATION: IST

MAILING ADDRESS:
Technical University of Istanbul
Institute of Seismology
Istanbul, Turkey

TELEPHONE NUMBER:
482250 (Ext. 135)

CABLE ADDRESS:
Not given

GEOGRAPHIC COORDINATES:
Latitude: 41° 2' 36" N
Longitude: 28° 59' 6" E

ELEVATION:
65 meters

HISTORY OF STATION:
World Array equipment began operating here on February 20, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is located in the city of Istanbul, approximately 1 km west of the Bosporus. There are no mountains or rivers in the immediate area. Istanbul is quite hilly, and the station is located in a large building near the crest of a fairly steep hill bordering the Bosporus.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The vault is in the basement of a large three-story building. There are buildings to the south and west, directly across city streets. A large vacant area is north of the station; to the east a hill slopes steeply downward to a busy street along the Bosporus. Traffic around the station is light.

LOCAL GEOLOGY:
The city of Istanbul rests on bedrock. The bedrock is Greywacke (Devonian), over 300 meters thick, and station piers rest directly on it.
STATION AND PIER CONSTRUCTION

PIERS:

The seismometer vault consists of six small rooms. The concrete seismometer piers extend 280 cm below the floor level and 60 cm above it. No reinforcing rods were used in the pier construction. There is a 5-cm separation between the piers and the floor. In the recording room, both the short- and long-period galvanometers are on piers similar to those described. Cables are passed from room to room through metal conduit pipes. Sufficient conduit pipes were installed to run signal cables in separate conduits to avoid pick up from power cables.

VAULT TEMPERATURE AND HUMIDITY:

There is no air conditioning. There were steam radiators and an electric heater for the seismometer rooms, but they caused noise in the long-period horizontals. The steam was turned off, the heater removed, and the temperature is now a fairly constant 22°C. Daily temperature fluctuations will not be more than 1/2°C. Seasonal fluctuations will be from approximately 25°C in the summer to 17°C in the winter. Humidity probably averages about 60-70%; no indicators are available. Humidity is probably higher in the winter, the rainy season.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 50000
SP N-S: 50000
SP E-W: 50000
LP Z: 750
LP N-S: 750
LP E-W: 750

None of the systems could operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: Not given

AVERAGE AMPLITUDES: Not given
VIEW OF ISTANBUL STATION

RECORDERS

SEISMOMETERS

RECORDERS & GALVANOMETERS
REMARKS: Little research on microseisms has been done here, since they are not a major problem. Only two or three days per year the Istanbul station will record heavy microseisms. Microseismic activity is greatest during the winter and lowest during the summer. On several of the daily records the predominant noise had a period of approximately 0.75 second. There are no local seismic disturbances near Istanbul. Wave action is no problem except during major storms. The Great Fault of Turkey cuts through the Sea of Marmara about 80 km south of Istanbul and extends eastward through northern Turkey in a great arc.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 4 km
The nearest highway is 2 km
The nearest river (Bosphorus) is 1 km

REMARKS: There is no apparent problem with other man-made noise.

OTHER INSTRUMENTS IN OPERATION:

(1) Hagiwara electromagnetic seismograph:
   - SP Z: Period 1.0, Mag. 50000
   - NS: Period 0.98, Mag. 40000
   - EW: Period 1.0, Mag. 47000
   - LP Z: Period 1.10, Mag. 680
   - NS: Period 1.07, Mag. 535
   - EW: Period 1.10, Mag. 800

(2) Grenet-Coulomb Z

RESEARCH PROJECTS IN PROGRESS:

Not given
STATION FACILITIES

STATION: Kevo, Finland
STATION DIRECTOR: Dr. Eijo Vesalanen
STATION ABBREVIATION: KEV
MAILING ADDRESS:
Seismological Laboratory
University of Helsinki
Helsinki, Finland

TELEPHONE NUMBER: 66-5782
CABLE ADDRESS: Seismo
Helsinki, Finland

GEOGRAPHIC COORDINATES:
Latitude: 69° 45' N
Longitude: 27° 0' E

ELEVATION: 95 meters

HISTORY OF STATION:
World Array equipment began operating here September 7, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is located 200 yards from the east shore of Kevo Lake, which is fed by the Utsjoki River. The station is isolated from cities and industrial sites.

STATION'S RELATION TO OTHER BUILDINGS OR MAN MADE STRUCTURES:
There are no buildings or man-made structures near the station.

LOCAL GEOLOGY:
The piers are resting on granulite. Because of glacial movement, this entire area has little topsoil.

STATION AND PIER CONSTRUCTION

PIERS:
The piers in the seismometer vault are constructed of concrete and are isolated from the floor. All seismometers are placed on one pier. Galvanometer piers consist of one row of brick, a wooden board, and a one-inch layer of cement on top.
CGS WORLD STANDARD SYSTEM, KEVO

1.27 m
CONSOLE ROOM

1.27 m
PIER ROOM KEVO

0.51 m

KEVO PIER
(Cross Section)
VAULT TEMPERATURE AND HUMIDITY:

Wide seasonal temperature changes are expected, but there are no means available for taking temperature readings in the vault. No humidity problem is foreseen in the instrument rooms, nor are any seasonal humidity fluctuations expected.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 50000 (at one cps)
SP N-S: 50000
SP E-W: 50000
LP Z: 1500 (at 30-sec period)
LP N-S: 1500
LP E-W: 1500

At present the LP Z could operate with increased magnification. All systems could operate at increased magnification if man-made noise were eliminated.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: Not given

AVERAGE AMPLITUDES: Not given

REMARKS: Microseismic activity at this station is very low. There are no other significant natural seismic disturbances here. The nearest earthquake epicenter location is about 300 to 400 km away.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 500 km
The nearest highway is 0.55 km (gravel road)
The nearest dam is 400 km
The nearest river is 0.18 km

REMARKS: There is no appreciable man-made noise during the winter, but in the summer some excessive noise will be caused by students from the University of Turku doing botanical research in areas adjacent to the seismometers. This will require the instruments to be operated at lower magnification.

OTHER INSTRUMENTS IN OPERATION:

1. Nurmia SP (smoked paper recording)
2. Meteorological instruments

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Kipapa, Hawaii

STATION DIRECTOR:
Lt. Cmdr. C. D. Upham

MAILING ADDRESS:
Honolulu Observatory
U. S. Coast & Geodetic Survey
91 - 270 Ft. Weaver Rd.
Ewa Beach, Oahu, Hawaii

TELEPHONE NUMBER:
Navy Phone: 4711 (Ext. 65107)
288 207

CABLE ADDRESS:
Honolulu Observatory
c/o Naval Communications Station
Honolulu, Hawaii

GEOGRAPHIC COORDINATES:
Latitude: 21° 25' 24" N
Longitude: 158° 54' W

ELEVATION:
70 meters

HISTORY OF STATION:
World Array equipment began operating here on November 9, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The Kipapa station is located in a tunnel 250 feet long in the side of a canyon (Kipapa Gulch). The tunnel is 50 feet above the bed of an intermittent stream and 150 feet below the top of the canyon. The canyon is cut into the Schofield Plateau which lies between the Koolau and Waianae mountain ranges. These mountain ranges are the remnants of the two volcanoes which coalesced to form the island of Oahu. The station is 3.2 km from Waipahu city and 6.4 km from the Waianae Mountains to the west.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is isolated, about 2500 feet from the Roosevelt Bridge which carries the Kamehameha Highway (99), the main highway in central Oahu, over Kipapa Gulch. The nearest point on the highway is 1500 feet from the station. No buildings of any consequence are nearby. There is a lookout tower about 1200 feet from the tunnel entrance. An irrigation canal about 8 feet wide
and 6 feet deep runs along the top of the canyon above the tunnel, about 200 feet east of the seismometer vaults. About 900 feet to the east and 150 feet above the seismometer vaults is an irrigation pump.

LOCAL GEOLOGY:

The station is located in the Schofield Plateau which is formed from lava flows from the Koolau and Waianae volcanoes. The Kipapa tunnel is cut in the side of a canyon of basalt of the Koolau Volcanic Series (Tertiary).

STATION AND PIER CONSTRUCTION

PIERS:

The piers are made of concrete, isolated from the concrete floor of the vault, and extending approximately 3 feet below floor level and 1 1/2 feet above. They rest on weathered basalt.

VAULT TEMPERATURE AND HUMIDITY:

Four dehumidifiers are in the tunnel: one in the World Array recording room, one in the vault between the SP vault and the large room, and two in the large room. If it should become necessary, one of the dehumidifiers can be moved into the SP or LP vaults. With the dehumidifiers operating, humidity will be below 70% throughout the tunnel and below 60% much of the year. No wide seasonal or daily temperature fluctuations are expected. The temperature range in the seismometer vaults should be between 77°F and 83°F all year.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>12500</td>
</tr>
<tr>
<td>SP N-S</td>
<td>12500</td>
</tr>
<tr>
<td>SP E-W</td>
<td>12500</td>
</tr>
<tr>
<td>LP Z</td>
<td>750</td>
</tr>
<tr>
<td>LP N-S</td>
<td>750</td>
</tr>
<tr>
<td>LP E-W</td>
<td>750</td>
</tr>
</tbody>
</table>

During the summer, all systems can operate at increased magnification.
THE LOCATION OF KIPAPA STATION IN KIPAPA GULCH

THE ENTRANCE TO THE TUNNEL WHICH HOUSES KIPAPA STATION
BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 4 and 6 to 8 sec

AVERAGE AMPLITUDES: See Remarks

REMARKS: During the winter microseismic activity is greatest; during the summer it is least. Four-second microseisms are recorded throughout the year; their average amplitude during the summer is 5 \( \mu \), during the winter 15 \( \mu \). The 6- to 8-sec microseisms reach an amplitude of 80 \( \mu \) or more during winter. The sources of these microseisms are storms and low pressure systems near the Hawaiian Islands. Distant meteorological disturbances such as western Pacific typhoons and Alaskan storms are also possible sources.

MAN-MADE NOISE:

FROM THE SEISMOGRAPH VAULT:

- The nearest railroad is 19.2 km (small railroad)
- The nearest highway is 0.46 km
- The nearest dam is 9.6 km (small spillway)
- The nearest river is 0.08 km (small stream)

REMARKS: There are high frequency microseisms (2 to 5 cps) averaging about 0.05 \( \mu \), probably caused by traffic on nearby Kamehameha Highway and on the bridge over Kipapa Gulch. Pineapple picking and activities within Wiehele Ammunition Depot are other possible noise sources. High-frequency noise is of much higher amplitude during the day.

OTHER INSTRUMENTS IN OPERATION:

- Benioff Z (period = 1 sec, Mag. = 30000)

RESEARCH PROJECTS IN PROGRESS:

1. T-Phase studies
2. Microseism studies
STATION FACILITIES

STATION: Kongsberg, Norway

STATION DIRECTOR:
Dr. A. Kvale

STATION ABBREVIATION: KON

MAILING ADDRESS:
Jordskjelvstasjonen
Villavei 9
Bergen, Norway

TELEPHONE NUMBER:
15976

CABLE ADDRESS:
Not given

GEOGRAPHIC COORDINATES:
Latitude: 59° 39' N
Longitude: 9° 35' E

ELEVATION:
300 meters (approx.)

HISTORY OF STATION:
World Array equipment began operating here June 28, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
Not given

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located in an abandoned silver mine, 300 meters down and 2200 meters into
the side of a hill. The mine is isolated.

LOCAL GEOLOGY:
Not given

STATION AND PIER CONSTRUCTION

PIERS:
See diagrams
AREA AROUND SEISMMETER VAULT, KONGSBERG
SEISMOMETER VAULT KONGSBERG, NORWAY
Recording Room
VAULT TEMPERATURE AND HUMIDITY:

No environmental control is present. Temperature in the mine is very stable (56°F to 58°F). No seasonal or daily temperature fluctuations are expected in the instrument rooms. Humidity is approximately 75% and steady. The vault is next to an area chosen by mine personnel for wheat storage, and no humidity problem is anticipated.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 50000
SP N-S: 50000
SP E-W: 50000
LP Z: 1500
LP N-S: 1500
LP E-W: 1500

BACKGROUND AND NOISE:

Not given

MAN-MADE NOISE:

Not given

OTHER INSTRUMENTS IN OPERATION:

None

RESEARCH PROJECTS IN PROGRESS:

Not given
STATION FACILITIES

STATION: Lahore, Pakistan

STATION DIRECTOR:
Dr. A. Q. Khan

STATION ABBREVIATION: LAH

MAILING ADDRESS:
Regional Meteorological Centre
46 Jail Road
Lahore, Pakistan

TELEPHONE NUMBER:
2250

CABLE ADDRESS:
Weather
Lahore, Pakistan

GEOGRAPHIC COORDINATES:
Latitude: 31° 30' N
Longitude: 74° 20' E

ELEVATION:
210 meters

HISTORY OF STATION:
The station began operation in 1952 with two Milne-Shaw horizontal seismographs. Dr. Thirlaway was the director, and Mr. Emaduddin Ahmed served as Officer-in-Charge. Three Sprengnether short-period instruments were placed in operation in 1955 and operated at a temporary site until 1957. They were then shifted to the permanent vault where they operated until the installation of the Standard System. Recently they were again transferred to the temporary site, and they are currently in operation. It is expected that use of these instruments will be suspended as familiarity with the new system increases. Mr. A. Q. Khan replaced Dr. Thirlaway in 1955 and is still Station Director. Mr. Mohammed Idrees replaced Mr. Ahmed in 1956 and was, in turn, replaced by the present Officer-in-Charge, Mr. A. H. Rizvi. World Array equipment began operating here September 4, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The area is flat and arid most of the year. Small canals present are of no seismic significance. The city of Lahore is about 1.6 km west of the station, and its main thoroughfares are nearby.
STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:

The station is located in one of the three buildings of the Meteorological Centre and contains offices as well as the vault and the recording room. Roads surround the vault on three sides, the closest being less than 100 feet to the south. Numerous large buildings stand within a few hundred yards of the vault.

LOCAL GEOLOGY:

Subsurface to a depth of about 1200 feet consists of alluvium with alternating layers of sand, clay, and gravel. The bedrock is probably a mica schist, although complete information is not available.

STATION AND PIER CONSTRUCTION

PIERS:

See diagrams

VAULT TEMPERATURE AND HUMIDITY:

There is no environmental control at present. Seasonal fluctuations can be expected in both vault and recording room:

<table>
<thead>
<tr>
<th></th>
<th>Recording room:</th>
<th>Vault:</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>100(^\circ)-110(^\circ)F (May and June)</td>
<td>High 100(^\circ)-110(^\circ)F (May and June)</td>
</tr>
<tr>
<td>Low</td>
<td>40(^\circ)-50(^\circ) (Dec and Jan)</td>
<td>Low 70(^\circ)F (Dec and Jan)</td>
</tr>
</tbody>
</table>

Humidity is high, highest during the monsoon season (July and August) and the winter. Total variation will be about 25\%. Outside variations can be as great as 65\%, from 20\% in May to 85\% in December.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>6161</td>
</tr>
<tr>
<td>SP N-S</td>
<td>6265</td>
</tr>
<tr>
<td>SP E-W</td>
<td>6227</td>
</tr>
<tr>
<td>LP Z</td>
<td>'742</td>
</tr>
<tr>
<td>LP N-S</td>
<td>749</td>
</tr>
<tr>
<td>LP E-W</td>
<td>760</td>
</tr>
</tbody>
</table>

The LP Z could possibly operate at increased magnification.
LOCATION SKETCH LAHORE, PAKISTAN
RECORDING ROOM

All Piers 3 feet above floor level.
Galvo Pier extends 6 feet below floor.

BUILDING IN WHICH THE STANDARDIZED EQUIPMENT HAS BEEN INSTALLED, ALSO SHOWING RADIO ANTENNA WHICH WAS CONSTRUCTED
BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 0.5 to 1.5 sec

AVERAGE AMPLITUDES: 0.16 to 0.32 μ (SP)

REMARKS: There are seasonal amplitude fluctuations, but adequate data on them are not available. No studies of microseismic activity have been made at this station. There are no other natural seismic disturbances at this location.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 4.8 km
The nearest highway is 100 yds
The nearest dam is 240 km
The nearest river is 3.3 km

REMARKS: Most noise at this location is from automobile traffic and people moving in and near the building which houses the instruments. This type of noise is readily transmitted by the subsurface alluvium and almost impossible to eliminate.

OTHER INSTRUMENTS IN OPERATION:

Sprengnether series H, 3-component system.

<table>
<thead>
<tr>
<th>Comp.</th>
<th>Period</th>
<th>Damping</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>1.8 sec</td>
<td>Critical</td>
<td>4900</td>
</tr>
<tr>
<td>N-S</td>
<td>1.7 sec</td>
<td>Critical</td>
<td>4200</td>
</tr>
<tr>
<td>E-W</td>
<td>1.6 sec</td>
<td>Critical</td>
<td>4100</td>
</tr>
</tbody>
</table>

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Longmire, Washington

STATION DIRECTOR:
Dr. E. A. Kaarsberg

STATION ABBREVIATION: LON

MAILING ADDRESS:
Dept. of Geology
Seismograph Station
University of Washington
Seattle 5, Washington

TELEPHONE NUMBER:
5431096 (Ext. 3251)

CABLE ADDRESS:
Same as mailing address

GEOGRAPHIC COORDINATES:
Latitude: 46° 45' N
Longitude: 121° 48.6' W

ELEVATION:
840 meters

HISTORY OF STATION:
Operation began on March 12, 1958. The original director was Mr. Frank Neumann, who retired on July 1, 1962. The present director is Dr. Kaarsberg. World Array equipment began operating here August 22, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
See topographic map

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
Small living quarters are the only buildings nearby.

LOCAL GEOLOGY:
The station is located on well consolidated volcanics associated with the Mt. Rainier area. Underlying the volcanics are strata of granodiorite, andesite, and well indurated black argillite. The basement rock is a granodiorite batholith. Strata thicknesses are not known.
STATION AND PIER CONSTRUCTION

PIERS:
The LP galvanometer pier is solid concrete and attached to the bedrock. LP and SP recorder piers, and SP galvanometer piers are 8-inch by 12-inch cement blocks attached to the floor. A 2-inch concrete slab is bonded to the top. Interior walls are made of beaverboard and have 6 inches of insulation. The ceiling is made of similar material and has 3 inches of insulation between the rafters.

VAULT TEMPERATURE AND HUMIDITY:
Minimum and maximum temperature readings are 10°F in January and 90°F in July and August. There is electrical, thermostatically controlled floor heat in the control and recording rooms. However, variations from 40°F to 60°F are expected in the seismometer room. Humidity conditions have not been ascertained.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>200000</td>
</tr>
<tr>
<td>SP N-S</td>
<td>200000</td>
</tr>
<tr>
<td>SP E-W</td>
<td>200000</td>
</tr>
<tr>
<td>LP Z</td>
<td>1500</td>
</tr>
<tr>
<td>LP N-S</td>
<td>1500</td>
</tr>
<tr>
<td>LP E-W</td>
<td>1500</td>
</tr>
</tbody>
</table>

At times, all SP components could operate at increased magnification. Upon installation of a styrofoam cover and a heat element, the LP Z could operate at gains of from 3000 to 6000.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 3 to 6 sec

AVERAGE AMPLITUDES: 1 to 2 μ (approx.)

REMARKS: The station is located in a lightly seismic region of the Circum-Pacific Belt. There is a slight increase in microseismic activity in the winter months, during local meteorological disturbances, and during storms off the Washington coast. Other natural seismic disturbances consist of local earthquakes of almost all magnitudes. Local activity is associated with faulting in the Puget trough and the North Coastal and Cascade Mountains. These shocks are generally of low intensity and exhibit "P" velocity of less than 8 km/sec. The Cascade system exhibits minor volcanic activity, principally in the Mt. Lassen area. The Mt. Rainier area is also characterized by numerous landslides and rock and ice falls.
PIER CONSTRUCTION LONGMIRE WASHINGTON. NOTE: Seismometers were placed in this position to achieve maximum use of the pier connected to the bedrock (note cut out sections of pier in diagram).
FLOOR PLAN SEISMOMETER VAULT LONGMIRE, WASHINGTON
MAN-MADE NOISE:

REMARKS: The installation at Longmire experiences very little man-made noise. The vault is approximately 1000 feet from a park highway, where traffic is light except on summer weekends. The nearby river (1000 feet) is not recorded as background except when running full.

OTHER INSTRUMENTS IN OPERATION:

Short-period Benioff pendulum with Geo-Tech galvanometer; vertical, E-W and N-S components, 200000 magnification.

Long-period Sprennether pendulum; vertical, E-W and N-S components, 1500 magnification.

RESEARCH PROJECTS IN PROGRESS:

This installation will be used by Washington University to continue research in local epicenter determination, crustal studies, and fault investigations.
STATION FACILITIES

STATION: La Plata, Argentina
STATION DIRECTOR: Simon Gershanik

STATION ABBREVIATION: LPA
MAILING ADDRESS:
Observatorio Astronomico
Paseo Del Bosque
La Plata
Rep. Argentina

TELEPHONE NUMBER:
2-7308
CABLE ADDRESS: None

GEOGRAPHIC COORDINATES:
Latitude: 34° 54' 32'' S
Longitude: 57° 55' 52'' W
ELEVATION: 15.3 meters

HISTORY OF STATION:

The station's history begins in 1907 with the installation of a 3-component Vicentini system. The two horizontal had a 2-second period, the vertical a 1-second period. The station has continuous records from two horizontal Mainka seismometers (8-sec period, 170 magnification) since 1922. A Wiechert vertical seismometer with a 14-second period and a magnification of 80 was in operation from 1925 to 1957. In 1950 a 14-second Sprengnether seismometer with a 14-second Northrop and Leeds galvanometer was added. World Array equipment began operating here on March 23, 1962.

Directors: Dr. Galdino Negri (1907 to 1922)
Dr. W. J. Hussey (1922 to 1925)
Dr. Federico Lunkenheimer (1925 to 1935)
Simon Gershanik (1935 to )

STATION ENVIRONMENT

LOCAL GEOGRAPHY:

La Plata is about 6.4 km southwest of the La Plata River, an estuary. It is 160 km inland from the Atlantic Ocean and 80 km southeast of Buenos Aires. The nearest mountain chain, Sierra Pampeanas, is approximately 400 km to the southwest. The area for a radius of 400 km is a coastal alluvial plain.
STATION’S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:

The vault is located at the Astronomico Observatorio on the campus of the University of La Plata. The observatory is in the northeast quadrant of the city. There are two domes, 80 feet in diameter and 90 feet high. One is approximately 200 feet to the west of the vault; the other is approximately 300 feet SW. There is a 100-foot tower which houses an instrument for measuring the velocity and direction of the wind 600 feet NW of the vault.

LOCAL GEOLOGY:

The area is composed of Quaternary loess approximately 600 feet thick.

STATION AND PIER CONSTRUCTION

PIERS:

The seismometer piers are on the floor of the seismometer vault. They extend 1 meter below the floor of the vault and are fixed in loosely consolidated material since the bedrock is at a depth of 600 feet. These piers are separated from the floor of the vault. The short-period pier is separated from the long-period pier, and both are constructed of brick and concrete, partly reinforced with iron.

VAULT TEMPERATURE AND HUMIDITY:

There are no heaters, air conditioners, or dehumidifiers in the seismometer room, recording room, or console room. Seasonal or daily temperature fluctuations are not expected. The highest temperature is expected in January, and the lowest in July.

Average high temperature in January: 22.5°C
Average low temperature in July: 9.7°C
Average yearly temperature: 15.8°C
Average high humidity: 82% (June)
Average low humidity: 65% (January)

The humidity at times will be very high in the recording room.
SEISMMOMETER VAULT
SEISMOMETER VAULT PIER ROOM

Scale 1 foot
STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:
SP Z: 3125
SP N: 3125
SP E: 3125
LP Z: 750
LP N: 750
LP E: 750

BACKGROUND AND NOISE:
Not given

MAN-MADE NOISE:
Not given

OTHER INSTRUMENTS IN OPERATION:
There are no other instruments operating in the vault, but in the administration building of the observatory there are two Mainka horizontal seismometers. Their mass is 450 kg, the damping ratio is approximately 4:1, magnification is approximately 150, and the period of both is 8 sec.

RESEARCH PROJECTS IN PROGRESS:
Not given
STATION FACILITIES

STATION: La Paz, Bolivia

STATION DIRECTOR:
Rev. Ramon Cabré, S. J.

STATION ABBREVIATION: LPB

MAILING ADDRESS:
Observatorio San Calixto
Casilla 283
La Paz, Bolivia

TELEPHONE NUMBER:
4422

CABLE ADDRESS:
San Calixto

GEOGRAPHIC COORDINATES:
Latitude: 16° 31' 57.6'' S
Longitude: 68° 05' 54.1'' W

ELEVATION: 3292.1 meters

HISTORY OF STATION:
Founder of Station and Director: Rev. Pierre M. Descotes, S. J. (1912-58)
Acting Director: Rev. Ramon Cabré, S. J. (1958-)

World Array equipment began operating here April 7, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:

The station is in a small canyon of very compact clay. It is 4.7 km from the Altiplano (High Plateau). A ravine, which has water flowing in it during the rains (November to March), is adjacent to the station. A small river, with falls and turbulent water, is about 340 meters from the station.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:

The station is located in a field of the Colegio San Calixto. New school buildings will be built about 150 meters from the station. At present, the nearest buildings are some barracks 350 meters away which are usually empty. The distances to residential areas are: Obrajones, 600 meters; Calacoto, 1.2 km; and La Paz, 3 km. The manufacturing area is over 4.5 km away. The distance to the nearest highway is 450 meters and to the nearest railway 6.5 km.
LOCAL GEOLOGY:

The La Paz formation, on which the station is located, consists of very compact clay with thin layers of sand running through it. Close to the station, this formation is covered with the Miraflores gravel terrace. Two kilometers to the south is a cut of the Puka formation (Red Limestone). Slates and quartzite appear about 10 km from the station.

STATION AND PIER CONSTRUCTION

PIERS:

See drawings

VAULT TEMPERATURE AND HUMIDITY.

There is no environmental control present. There may be a very slight daily temperature fluctuation in the recording and console rooms during winter. It is extremely warm in the day and very cold at night. However, since the building is concrete and the roof is covered with stones to hold heat, temperature variation will be slight (5°C). Since the seismometer vault is covered with dirt, it will have no temperature fluctuation. The relative humidity in both the recording room and the seismometer vault will be very high during the rainy season.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>50000</td>
</tr>
<tr>
<td>SP N-S</td>
<td>50000</td>
</tr>
<tr>
<td>SP E-W</td>
<td>50000</td>
</tr>
<tr>
<td>LP Z</td>
<td>1500</td>
</tr>
<tr>
<td>LP N-S</td>
<td>1500</td>
</tr>
<tr>
<td>LP E-W</td>
<td>1500</td>
</tr>
</tbody>
</table>

BACKGROUND AND NOISE:

REMARKS: There are two ranges of periods of microseisms predominant in La Paz. Throughout the year, there appears on the records, and on the new SP equipment, a noise with a period of less than one second. It is of small amplitude and has not been studied. More variable are the microseisms (supposed to be originating in the Pacific Ocean) with periods between 6 and 8 seconds. Their mean amplitude during the 18 months of IGY was 0.53 μ. These measurements were taken in the old San Calixto station with a Galitzin-Wilip set.
RELATIONSHIP OF SEISMOMETER VAULT TO RECORDING ROOM

Seis. Vault

Conduit Carrying Signal and Calibration Cable

≈ 60 m

Recording and Developing Bldg

Ravine Approx.
10-15 meters Deep
Conduit Enters from Seis. Vault
Galvo. Pier-Constructed of Concrete and Separated from Floor Recorders
Foam Rubber
Pier Has Been Dug Down to Very Compact Clay. Asphalt Poured Down Side of Pier to a Depth of 10 cm to Prevent Water Seepage.

CROSS-SECTION OF RECORDING ROOM

Scale 5 feet
RECORDING BUILDING
MAN-MADE NOISE:

Not given

OTHER INSTRUMENTS IN OPERATION:

Although there is no other equipment at the new site in Sequencoma, there is a great deal of seismic and meteorological instrumentation at the old station in the city, 6 km away:

<table>
<thead>
<tr>
<th>Components</th>
<th>Type</th>
<th>Period</th>
<th>Galvanometer Type</th>
<th>Period</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>Galitzin-Wilip</td>
<td>10.0</td>
<td>Hartman &amp; Braun</td>
<td>11.8</td>
<td>1000</td>
</tr>
<tr>
<td>NS</td>
<td>Galitzin-Wilip</td>
<td>12.6</td>
<td>Hartman &amp; Braun</td>
<td>12.5</td>
<td>1500</td>
</tr>
<tr>
<td>EW</td>
<td>Galitzin-Wilip</td>
<td>12.0</td>
<td>Hartman &amp; Braun</td>
<td>12.6</td>
<td>1500</td>
</tr>
<tr>
<td>Z</td>
<td>Wilson-Lamison</td>
<td>1</td>
<td>General Electric</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>EW</td>
<td>Vertical Pend.</td>
<td>2.4</td>
<td></td>
<td></td>
<td>700</td>
</tr>
<tr>
<td>NS</td>
<td>Horizontal Pend.</td>
<td>14</td>
<td></td>
<td></td>
<td>180</td>
</tr>
<tr>
<td>EW</td>
<td>Horizontal Pend.</td>
<td>12</td>
<td></td>
<td></td>
<td>300</td>
</tr>
</tbody>
</table>

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: La Palma, El Salvador

STATION DIRECTOR:
Dr. Rudolf Schulz

STATION ABBREVIATION: LPS

MAILING ADDRESS:
Dr. Rudolf Schulz
Servicio Geologico Nacional
la Calle Poniente No. 925
San Salvador
El Salvador, C. A.

TELEPHONE NUMBER:
7453

CABLE ADDRESS:
Not given

GEOGRAPHIC COORDINATES:
Latitude: 14° 17' 32" N
Longitude: 89° 09' 43" W

ELEVATION:
1000 meters (approx.)

HISTORY OF STATION:
World Array equipment began operating here July 2, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is in the mountains, 81 km north of San Salvador and 4 km south of the village of La Palma. A small river, with 2- or 3 meter waterfalls during the rainy season, is 1/2 km to the south. The noise of the waterfalls is not recorded.

STATION’S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located at El Refugio, a vacation colony operated by the government. The colony consists of fifty cabins and a large main building for eating and dancing. The vault is isolated from any camp activity. A small generator, the station power source, is located 200 meters east of the vault. A secondary camp road is 75 meters north of the station. The few vehicles that pass here will be recorded.

LOCAL GEOLOGY:
Bedrock consists of intrusive granite, which is found in the stream beds and mountains near the station. The cover depth at the station is approximately 10 meters. Geology of this area has not been completely studied.
STATION AND PIER CONSTRUCTION

PIERS:

The piers are constructed of concrete and extend one foot above and approximately three feet below ground level. They are not attached to bedrock, which is approximately 33 feet deeper. There is a two-inch isolation gap around the pier which is filled with sand. Because the piers are sitting on dirt and are not attached, the instruments are disturbed by any movement in or near the building.

VAULT TEMPERATURE AND HUMIDITY:

No environmental control is present. The temperature does not vary more than 2.5°C inside the vault (23.5°C to 26°C). Outside temperature will vary from 28°C (February to April) to 7°C (November to December). During the rainy season (May to October) the humidity will be 85% to 95%. From November to April humidity should be 60%.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>100000</td>
</tr>
<tr>
<td>SP N-S</td>
<td>100000</td>
</tr>
<tr>
<td>SP E-W</td>
<td>100000</td>
</tr>
<tr>
<td>LP Z</td>
<td>1500</td>
</tr>
<tr>
<td>LP N-S</td>
<td>1500</td>
</tr>
<tr>
<td>LP E-W</td>
<td>1500</td>
</tr>
</tbody>
</table>

None of the systems could operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 1 and 8 seconds

AVERAGE AMPLITUDES: not given

REMARKS: During heavy rainfall a noticeable increase in microseismic disturbance appears on both long- and short-period systems. The greatest microseismic activity will be from August through September, during the hurricane season in the Caribbean Sea. In November and December there are strong north winds. Other natural seismic disturbances are many local earthquakes and occasional volcanic activity.
PIER CROSS-SECTION

STATION
MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

  The nearest highway is 1 km (secondary highway)
  The nearest dam is 60 km
  The nearest river is 1/2 km (small river)

REMARKS: Any traffic on the secondary camp road 75 meters north of the vault will cause a noticeable disturbance on both long- and short-period records. Disturbances due to poor pier isolation will appear at the beginning and end of each day's records.

OTHER INSTRUMENTS IN OPERATION:

  Not given

RESEARCH PROJECTS IN PROGRESS:

  Not given
STATION FACILITIES

STATION: Lubbock, Texas
STATION DIRECTOR: Deskin H. Shubert
STATION ABBREVIATION: LUB
MAILING ADDRESS:
Seismological Observatory
Texas Technological College
Lubbock, Texas
CABLE ADDRESS:
SEISLUB

TELEPHONE NUMBER:
Porter 2-8811 (Ext. 3253)

GEOGRAPHIC COORDINATES:
Latitude: 33° 35' N
Longitude: 101° 52' W
ELEVATION: 200 meters

HISTORY OF STATION:
World Array equipment began operating here December 12, 1961.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is on the campus of Texas Technological College, about 1.6 km west of Lubbock, in the southeastern portion of the high plains area of Texas. There are no mountains or large rivers nearby.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is surrounded by buildings of Texas Technological College.

LOCAL GEOLOGY:
The seismic pier is set in caliche. The caliche overlies Pleistocene terrestrial deposits from 150 to 250 feet thick. Caliche stringers, ranging in thickness from a few feet to about 50 feet, are present throughout the deposits.
STATION AND PIER CONSTRUCTION

PIERS:

The recording and galvanometer piers go only as deep as the building foundation, i.e., two feet. All cables are transported in conduit. The signal cables are in a conduit separated from the power conduit.

VAULT TEMPERATURE AND HUMIDITY:

Heat is controlled by a thermostat in the console room. The vault and recording room have no temperature control. The vault, being underground and well insulated, maintains a constant temperature, with less than 1°F temperature change daily, and yearly changes of about 5°F expected. Temperature fluctuations are expected in the recorder and console rooms. Annual temperature change outside is about 40°F, and daily changes are about 4°F to 5°F. Humidity is low throughout the year.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 50000
SP N-S: 50000
SP E-W: 50000
LP Z: 3000
LP N-S: 3000
LP E-W: 3000

None of the systems could operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 6 sec

AVERAGE AMPLITUDES: About 2 mm on long-period system (with magnification of 3000)

REMARKS: Microseisms are stronger in winter than in summer when they are of very low amplitude. All microseisms seem to come from the Gulf Coast, Northern Pacific Coast, or Atlantic Coast. The strongest recorded are associated with cold fronts that move through to the Gulf Coast. There is nothing in the immediate area that would produce microseisms. There are no other natural seismic disturbances in this area.
Recorder and Galvo Piers are Attached to the Building

The 3-Inch Conduit is Used to Carry Cables from Vault to Existing Buildings

BEARING SURFACE CONSISTS OF APPROX. 25 CYLINDRICAL-SHAPED FOOTINGS.
MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 1.6 km
The nearest highway is 0.8 km

REMARKS: Several buildings are under construction on the campus and this causes most of the short-period noise. The nearest work being done is about 100 feet away. To this is added the daily campus traffic. Roads surround the campus. Trains to the west of the campus cause a burst of high-frequency noise at various times throughout the day. Infrequent quarry blasts are recorded from two caliche quarries on the outskirts of Lubbock.

OTHER INSTRUMENTS IN OPERATION:

<table>
<thead>
<tr>
<th>Seismometer Type</th>
<th>Period</th>
<th>Calvanometer Type</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprengnether</td>
<td>10 sec</td>
<td>Lerner-Griffith</td>
<td>90 sec</td>
</tr>
<tr>
<td>Sprengnether</td>
<td>6 sec</td>
<td>Leeds-Northrop</td>
<td>6 sec</td>
</tr>
<tr>
<td>Sprengnether</td>
<td>6 sec</td>
<td>Leeds-Northrop</td>
<td>6 sec</td>
</tr>
<tr>
<td>Sprengnether</td>
<td>2 sec</td>
<td>Leeds-Northrop</td>
<td>2 sec</td>
</tr>
<tr>
<td>Sprengnether</td>
<td>2 sec</td>
<td>Leeds-Northrop</td>
<td>2 sec</td>
</tr>
<tr>
<td>Sprengnether</td>
<td>2 sec</td>
<td>Leeds-Northrop</td>
<td>2 sec</td>
</tr>
</tbody>
</table>

One visual recorder coupled to the SP Z is also in operation at the station.

RESEARCH PROJECTS IN PROGRESS:

Surface wave research
STATION FACILITIES

STATION: Malaga, Spain

STATION ABBREVIATION: MAL

STATION DIRECTOR:
Dr. Alfonso Lopez Arroyo

MAILING ADDRESS:
Office of Commercial Attaché (MAL)
American Embassy
APO 285
New York, N.Y.

TELEPHONE NUMBER:
12018

CABLE ADDRESS:
Observatorio Sismologico
Malaga, Spain
Telephone 12018

ELEVATION:
60.3 meters

GEOGRAPHIC COORDINATES:
Latitude: 38° 13' 30'' N
Longitude: 4° 24' 40'' W

HISTORY OF STATION:
The building and the surrounding area of the observatory was given to the Geographical Institute by the city of Malaga in 1912. The station began to make regular observations in 1915.

In 1950 a set of three-component, short-period (1.5 seconds for both seismometer and galvanometer) seismographs, built by Askania, began operation. Victoria and Wiechert instruments were taken out of operation in 1961 to accommodate the installation of the standardized equipment. World Array equipment began operating here April 26, 1962. The observatory at Malaga has had the following directors:

1914-1919: José Rodriguez de Cordoba
1919-1920: Jose Poyato Osuna
1920-1922: José Rodriguez de Cordoba
1922-1932: Juan Garcia de Lomas
1932-1934: Felix Gomez-Guillamon
1934-1938: Luis Cadarso Gonzalez
1938-1958: Felix Gomez-Guillamon
1958-: Alfonso Lopez Arroyo
STATION ENVIRONMENT

LOCAL GEOGRAPHY:

The station is located in the city of Malaga and lies between the foothills of the Malagueho Mountains and the Mediterranean Sea. The observatory is a three-story structure on the eastern edge of the city, atop a hill about 50 meters above the city proper.

STATION’S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:

The station is fairly well isolated from Malaga’s centers of activity. The only large structure near the observatory is a castle on the southern slope of the hill below the station. The only other structures nearby are residences to the south and west. There is a breakwater and some shipping docks about 2.5 km SW. They are in the city proper and would tend to increase the microseismic activity on the long-period components during high winds.

LOCAL GEOLOGY:

Malaga is located in the tectonic unit called Cordilleras Beticas. This mountain range and the Pyrenees are the two alpine chains which shape the Iberian Peninsula on the north and SE. They are separated from the Hercinian block of the Central Massif by large depressions, the Guadalquivir and the Ebro basins. The Guadalquivir depression represents a deep fracture of the earth’s crust. It has a relatively high seismicity with foci at depths larger than normal. The Cordilleras Beticas can be divided into three main zones: Prebetic, Subbetic, and Betic. The Betic was formed between Upper Cretaceous and Middle Eocene time; the Subbetic was formed during Oligocene and Miocene time. The Guadalquivir depression was developed at the same time as the Subbetic. Later, strong erosion almost peneplained the Betic structures and caused them to undergo an isostatic upward motion, while the depression subsided under the weight of the sediments.

STATION AND PIER CONSTRUCTION

PIERS:

The piers in the seismometer room are concrete. Unfortunately, the quality of the concrete is poor and not a good solid foundation for the instruments. The piers are isolated from the floor by an air space of about 2.5 cm. They are attached to solid limestone of Tertiary age. The depth to the limestone from the vault floor is about one meter, and the pier rises into the vault about 0.5 meter.
Looking to the southwest from the top of the Observatory.

View of Observatory from the northwest corner.
VAULT TEMPERATURE AND HUMIDITY:

No environmental control is present. The summer months (May to September) have an average temperature of 23°C, with the highest temperatures recorded during July and August. The winter months (October to April) have an average temperature of 14°C, and the lowest temperature occurs during January. Daily fluctuations in temperature are small. Humidity is quite high in the seismometer room, but not a problem in the recorder-galvanometer room. Humidity remains fairly constant all year.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 25000
SP N-S: 25000
SP E-W: 25000
LP Z: 750
LP N-S: 750
LP E-W: 750

The vertical components of both systems could operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 0.5 to 6 sec

AVERAGE AMPLITUDES: SP 1500 µ; LP 750 µ

REMARKS: Greatest amplitude is during the winter and least amplitude is during the summer. The major causes of microseisms at this location are:

1) Cold fronts and wind storms (short-period microseisms)
2) Low pressure areas in the Mediterranean Sea (periods from 3 to 5 sec)
3) Low pressure areas in the Atlantic Ocean (periods from 6 to 9 sec)

There are no volcanic disturbances in the area. Local earthquakes are numerous, epicenters being from 50 to 100 km away, and come predominantly from the NE quadrant.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 500 meters
The nearest highway is 400 meters
There are no nearby dams or rivers
REMARKS: Any other man-made noise is so minute that it is masked by microseismic activity and cannot be distinguished.

OTHER INSTRUMENTS IN OPERATION:

Three Askania short-period seismometers (Z, N-S, E-W) are in use. The period of all the seismometers is 1.5 seconds. In addition there are three Askania recorders with galvanometers of a 1.5 second period. Magnification of the instruments is: Z, 8600; N-S, 7000; E-W, 7000.

RESEARCH PROJECTS IN PROGRESS:

(1) Seismicity of southern Spain
(2) Structure of Malagueña Province
(3) Wave dispersion along continental paths
STATION FACILITIES

STATION: Manila, Philippines

STATION DIRECTOR:
Dr. Roman L. Kintanar

STATION ABBREVIATION: MAN

MAILING ADDRESS:
Philippine Weather Bureau
Port Area, Manila
Philippines

TELEPHONE NUMBER:
3-64-01; 22-30-22

CABLE ADDRESS:
Weather Manila

GEOGRAPHIC COORDINATES:
Latitude: 14° 40' N
Longitude: 121° 05' E

ELEVATION: 70.4 meters

HISTORY OF STATION:
The station was completed in 1949. Mr. Arturo Alcaraz was the Chief Geophysicist. He was succeeded by Mr. Roman L. Kintanar in 1953. In 1957 Mr. Wellington Miñoza became the director and was succeeded by Dr. Kintanar. World Array equipment began operating here on July 14, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is located within the Balara Filters Reservation on the outskirts of Quezon City, beyond the University of the Philippines. The Marikina hills, about 3.2 km east of the station, run NNE to SSW. Beyond these hills 1.6 km is the Marikina River, and across it lies Marikina valley.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is east of the campus of the University of the Philippines. About thirty meters east of the station is a concrete water tank about 20 meters in diameter and 15 meters high. A large building 100 meters farther east houses the filtration laboratories. South of the station about 300 meters are open-air water reservoirs and office buildings of the Balara filtration plant, and immediately north is a golf course. A second-class road with very little traffic runs about 150 meters west of the station.
LOCAL GEOLOGY:

The bedrock upon which the station is situated is composed of Guadalupe volcanic tuff underlain by a relatively thicker layer of meta-volcanics and a basement complex, presumably of the Tertiary formations. The basement complex is at the base of the Marikina hills, which are made up mostly of folded alluvium and Guadalupe volcanic tuff. In the lower elevations to the west, alluvium predominates and extends down to Manila Bay.

STATION AND PIER CONSTRUCTION

PIERS:

See diagram

VAULT TEMPERATURE AND HUMIDITY:

No environmental control is present. It is recommended that either a dehumidifier or ventilators be used in the SP and recording rooms. Wide seasonal temperature fluctuations are expected, from a high of 100°F in April and May to a low 60°F in January and February. The instrument rooms will probably be about 5°F higher than the outside temperature unless something is done to lower temperature and humidity. Humidity is extremely high in the instrument rooms now, but it is thought to be because of the newness of the building. It is hoped that in time the cement will dry out thoroughly, and humidity will decrease.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 25000  
SP N-S: 25000  
SP E-W: 25000  
SP Z: 750  
LP N-S: 750  
LP E-W: 750

None of the components can operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 6 to 8 sec

AVERAGE AMPLITUDES: 2 μ
GEOLOGIC MAP ANTIPOLO-MONTALBAN AREA RIZAL PROVINCE PHILIPPINES
CROSS SECTION OF SEISMOMETER VAULT LOOKING WEST
REMARKS: From July to November, tropical disturbances increase amplitudes to 10 \( \mu \). Microseismic activity from local thunderstorms and strong winds is recorded frequently, with periods from 2 to 3 seconds and amplitudes usually not exceeding 4 \( \mu \). Extremely large local earthquakes are recorded here frequently. It is felt that an SP galvanometer could be broken by one of these strong shocks.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:
- The nearest railroad is 24 km
- The nearest highway is 3.2 km (small road, 150 meters)
- The nearest dam is 4.8 km
- The nearest river is 4.8 km

OTHER INSTRUMENTS IN OPERATION:
Weather instruments include a microbarograph, hydro-thermograph, several psychrometers and thermometers, a quadruple recorder that registers wind speed and direction, rainfall, and duration and intensity of sunshine, and several rain gauges. Seismic equipment consists of a 3-component electromagnetic Sprengnether seismograph. Instrument constants are:

- Horizontal: Seis. period = 12 sec; Galvo. period = 7.2 sec, Mag. = 3000
- Vertical: Seis. period = 1.5 sec; Galvo. period = 7.2 sec, Mag. = 1500

RESEARCH PROJECTS IN PROGRESS:
None
STATION FACILITIES

STATION: Madison, Wisconsin

STATION DIRECTOR:
Dr. Robert Meyer

STATION ABBREVIATION: MDS

MAILING ADDRESS:
Geophysical Research Center
2544 University Avenue
Madison, Wisconsin

CABLE ADDRESS:
Same as mailing address

ELEVATION:
273.6 meters

TELEPHONE NUMBER:
CE 8-5051 or CE 8-5992

GEOGRAPHIC COORDINATES:
Latitude: 43° 22' 20" N
Longitude: 89° 45' 36" W

HISTORY OF STATION:
World Array equipment began operating here on January 16, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is 64 km north of Madison, Wisconsin, on Highway 12. The nearest town to the south is Sauk City, Wisconsin (14.4 km); to the north it is 14.4 km to Baraboo, Wisconsin. The installation is on the southern flank of the Baraboo Range, and NE the terrain reaches a peak of 420 meters. Approximately 6.4 km SE is the Wisconsin River, and 12.8 km due east is Lake Wisconsin.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The console, recorders, and galvanometers are located in an old block house. The seismometer vault is 500 feet to the north. This area is on the northern edge of Badger Ordnance Works operated by Olin Matheson Chemical Corp. The plant is totally inactive and employs only a maintenance crew. The nearest occupied building is the filtering plant 0.8 km east. There is a railroad spur 0.8 km south, but this is seldom used.
LOCAL GEOLOGY:

Precambrian Baraboo Quartzite is the bedrock to which the seismometers are attached. It is the thickest and lowest formation of the Baraboo Sedimentary series and passes upward into the Seeley Slate, which grades into the Freedom formation. The Freedom formation consists of carbonates, of which dolomite is the most abundant. The Baraboo Quartzite folded during late Precambrian and formed a syncline with an axis trending from east-NE to west-SW. The northern limb of the syncline dips to the south from 60° to 90°. Its southern limb dips north from 20° to 30°. The Baraboo Quartzite rests unconformably upon intrusive and extrusive acidic igneous rocks and appears highly fractured around the installation site.

STATION AND PIER CONSTRUCTION

Figure 1 is an overall representation of the installation site and shows the relationship of the console and recording rooms to the seismometer vault. Pits A and B are 4 feet by 4 feet by 5 feet deep. The cable from the console room passes through these to the seismometer vault. From Building 303 to pit B the cable passes through 4-inch cassin buried about 3 feet underground. From pit B to the seismometer vault the cable passes through 2-inch plastic tubing 1 foot underground. From the entrance of the vault to the instruments the tubing is on the floor.

Figures 2 and 3 are scale drawings of the console and recording rooms, respectively, which are in an old block house constructed of reinforced concrete. Figure 2 shows the console near the entrance to the recording room. All cables pass through the top of the console to the ceiling, over to the wall, and then down to a pit. From here the calibration cables are routed to the seismometer vault as described and to the recording room through one of two pipes. These pipes, 2 inches in diameter, are buried and pre-laid. The signal cables from the seismometers to the galvonometers pass to the recording room through the other 2-inch pipe.

Figure 3 shows the galvonometers and control boxes on an isolated pier along the north wall of the recording room. The three drum recorders are on individual piers. There is ample room to pass between the galvanometer piers and the records.

Figure 4 is the drawing of the seismometer vault which is blasted into the side of a quartzite hill. Roof, floors, and walls are finished with reinforced concrete. The floor of the vault rests on the Baraboo quartzite and instruments sit on the floor. This makes the entire cave the seismometer piers. There is a small railroad track running down the center of the vault, closed off at both ends. As one enters the vault, the long-period seismometers are on the left side of the track and the short-periods on the right.
The temporary dark room shown in Figure 1 is a duplicate of the recording room shown in Figure 3, minus the piers. This is the room to be used by the University of Wisconsin for the installation of their recorders and galvanometers.
CONSOLE ROOM

Figure 2
VAULT TEMPERATURE AND HUMIDITY:

Two radiant type, 2-kilowatt heaters will be installed later, one in the console room, the other in the recording room. No air conditioning will be employed. There are wide seasonal temperature fluctuations. The average high in the summer is between 80° and 90°F, and in the winter the temperature falls well below 0°F. No wide daily fluctuations in temperature are expected. The humidity in the recording and console rooms will present no problem. In the seismometer vault humidity will be highest during the spring and the rainy season, and lowest (about 15%) in the summer.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 100000
SP N-S: 100000
SP E-W: 100000
LP Z: 750
LP N-S: 750
LP E-W: 750

None of the systems can operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 0.75 sec
AVERAGE AMPLITUDES: 2000 (peak to peak) μ (at 750 magnification)

REMARKS: A discussion of microseismic activity would be premature at this time since this is a new location and no records are available to review.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 6.4 km
The nearest highway is 2 km
The nearest dam is 9.6 km
The nearest river is 6.4 km

REMARKS: There is a rock quarry operating about 7.7 km north of the installation. The Baraboo quartzite is blasted about once or twice a week with 1- to 2-pound surface charges, and once a year with 4200 pounds. The 1- to 2-pound surface charges have not yet been recorded.
OTHER INSTRUMENTS IN OPERATION:

The following instruments are to be installed at a later date:

1. Benioff vertical seismometer, 1 cps with one Lehner-Griffith 90-second galvo,
   1 Geotech 5-cps galvo
2. Press-Ewing (L&G) vertical 30-second, with L&G 90-second galvo
3. Press-Ewing (L&G) horizontal 30-second, with L&G 90-second galvo
4. Lamont type microbarograph

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Minneapolis, Minnesota

STATION DIRECTOR:
Professor H. Mooney

TELEPHONE NUMBER:
373-3195

STATION ABBREVIATION: MNN

MAILING ADDRESS:
Department of Geophysics
School of Mines and Metallurgy
University of Minnesota
Minneapolis, Minnesota

CABLE ADDRESS:
Same as mailing address

GEOGRAPHIC COORDINATES:
Latitude: 44° 54' 52" N
Longitude: 93° 11' 24" W

ELEVATION:
213 meters

HISTORY OF STATION:
Construction of this station began in the summer of 1961. Professor H. Mooney has been the only director. World Array equipment began operating on July 27, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is located in a mine within the city of St. Paul. The entrance of the mine is near the Mississippi River, in the side of its steeply cut valley. The seismometers are about 2000 feet east of and 3 to 5 feet higher than the entrance. Except for the steep bank above the entrance, the surface is relatively flat and the mine is 100 to 130 feet below the ground surface.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The seismometers are located behind an automobile assembly plant. A railroad switching yard lies between the seismometers and the factory. A parking lot is 100 feet to the west. A three-story department store is 800 feet NE. The nearest bridge crossing the Mississippi River is 3000 feet NE of the seismometers.

LOCAL GEOLOGY:
The station is within the Saint Peter Sandstone about 130 feet above its base. The sandstone overlies the Shakopee-Oneota Dolomite, with granite about 2000 feet below the station. The Saint Peter Sandstone extends about 50 feet above the station where it is overlain by approximately 50-foot thick Platteville Limestone. Above this is about 30 feet of glacial drift.
TOPOGRAPHIC MAP OF MINNEAPOLIS—ST PAUL AREA
STATION AND PIER CONSTRUCTION

PIERS:

The piers are slabs of concrete, 1 foot thick, poured on the sandstone bedrock. The vault floor is loose sand about 3 inches deep and covers the bedrock. No pier isolation is considered necessary in the abandoned mine. The water table is about 1 1/2 feet below the base of the piers.

VAULT TEMPERATURE AND HUMIDITY:

No environmental control is present. Temperatures are constant for each location: seismometer 5°C, recorders 11°C, and console 11°C. Less than 3°C temperature variation is expected at this installation. Humidity control is recommended. Humidity is high enough to cause paper expansion during recording, though no other problems are expected at the recorders or console. Humidity in the seismometer vault is so high that water will condense on exposed objects and the piers are constantly wet. Although seasonal fluctuations may take place, humidity is expected to remain a problem. Meanwhile, two 200-watt lights will dry a pier overnight.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 50000
SP N-S: 50000
SP E-W: 50000
LP Z: 3000
LP N-S: 3000
LP E-W: 3000

The LP Z component could operate at a magnification of 6000.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 4 sec

AVERAGE AMPLITUDES: 0.5 (peak to peak) μ

REMARKS: The greatest microseismic activity is expected during January and February, the least during July and August. Microseisms are expected to be similar to those recorded at Madison and Ann Arbor. A natural background of 2-second period is apparently present, but it is nearly obscured by man-made background noise.
MINNEAPOLIS WORLD-ARRAY SEISMOGRAPH STATION CONTROL AND RECORDING AREA
MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 600 ft (switching work is continuous at times)
The nearest highway is 800 ft
The nearest dam is 2300 ft (includes a hydroelectric plant)
The nearest river is 2200 ft

REMARKS: Vibrations from an air compressor in the steam plant near the mine are very noticeable at the console. Machinery noises from the auto assembly plant are sometimes recorded. At the seismometers, no audible outside noise can be noticed. Strong sonic booms from jet planes occur about ten times a week. These have been identified on seismograms and have a period of 0.5 seconds, last about 15 seconds, and increase in amplitude slowly.

OTHER INSTRUMENTS IN OPERATION:

None

RESEARCH PROJECTS IN PROGRESS.

(1) The University of Minnesota has a computation project on Rayleigh wave dispersion curves.

(2) The standardized seismograph equipment is to be used in recording large blasts (about 10 tons) in the iron mines approximately 160 km north of the station. The data will be used for crustal studies.
STATION FACILITIES

STATION: Mundaring, Australia
STATION DIRECTOR:
P. M. McGregor
(Observer-in-Charge)
TELEPHONE NUMBER:
Mundaring 30

STATION ABBREVIATION: MUN
MAILING ADDRESS:
Observer-in-Charge
Mundaring Geophysical Observatory
Mundaring, Western Australia

CABLE ADDRESS:
Buromin
Mundaring
Western Australia

GEOGRAPHIC COORDINATES:
Latitude: 31° 58.7' S
Longitude: 116° 12.5' E

ELEVATION:
235 meters

HISTORY OF STATION:

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is isolated in a government water catchment reserve. A large weir is 0.8 km from the station. A very small township is 6.4 km distant. The closest suburb of Perth is 16 km away. There are no nearby rivers or mountains. The highest land for 160 km is about 600 meters in elevation.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is remote from any buildings. The nearest center of activity is 0.8 km away at the Mundaring weir where there is a forestry station and a large water-pumping station. Traffic in the area is light.

LOCAL GEOLOGY:
See geologic cross-sections.
STATION AND PIER CONSTRUCTION

PIERS:

The seismometer piers are of solid concrete, isolated from the vault floor by a 1-inch space. They are attached to granite bedrock which has been excavated 9 inches. The long-period pier is extended to 8 feet by 3 feet by a reinforced concrete slab mortared to the original surface. The recorder and galvanometer piers, made of brick, are set on the floor of the vault and surmounted by reinforced concrete slabs.

VAULT TEMPERATURE AND HUMIDITY:

There is environmental control. Daily temperature changes are not expected. Temperature is highest (29°C) in February, and lowest (14°C) in August. Humidity averages 45% in the summer, 75% in the winter. Daily humidity varies ±5%.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

- SP Z: 25000
- SP N-S: 25000
- SP E-W: 25300
- LP Z: 755
- LP N-S: 770
- LP E-W: 770

The LP horizontal could operate at increased magnification. Station personnel estimate that the SP system can be operated from 50000 to 100000 gain during months of least micro-seismic activity.

BACKGROUND AND NOISE:

- PERIODS OF PREDOMINANT MICROSEISMS: 1 to 2, 4, 6 to 8 sec
- AVERAGE AMPLITUDES: 6.1, 0.4, 1.5 μ

REMARKS: There are seasonal amplitude fluctuations, with maximum activity from June to August and least activity from January to March. There is an active seismic zone 100 km east of Mundaring. Earthquakes of magnitude 4 are recorded.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

- The nearest railroad is 11.2 km
- The nearest highway is 8 km
- The nearest dam is 0.8 km
- The nearest river is 6.4 km
REMARKS: Blasting is the only known source of man-made noise at this location. This occurs at quarries 13.2 km away, usually between 0400 and 0600 and between 0745 and 0815 GMT. $L_R$ waves from weaker explosions have the appearance of a group of weak P waves with a period of 1 second.

OTHER INSTRUMENTS IN OPERATION:
(1) Microbarograph
(2) Willmore and Benioff seismographs may be operated later.

RESEARCH PROJECTS IN PROGRESS:
None
STATION FACILITIES

STATION: Nhatrang, South Viet-Nam

STATION DIRECTOR:
Nguyen Hai

TELEPHONE NUMBER:
HAI-HOC-VIEN (Nhatrang)

STATION ABBREVIATION: NHA
MAILING ADDRESS:
Seismological Station
Oceanographic Institute
Nhatrang, South Viet-Nam

CABLE ADDRESS:
DIROCEANO or HAIHOCVIEN
NHA TRANG

GEOGRAPHIC COORDINATES:
Latitude: 12° 12' 36" N
Longitude: 109° 12' 42" E

ELEVATION:
5 meters

HISTORY OF STATION:
The station was set up in July 1957 as part of IGY. Instrumentation consisted of a 3-component SP electromagnetic seismograph from France. World Array equipment began operating on June 13, 1962. Nguyen Hai has always been the director.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station, which belongs to the Oceanographic Institute, is 6 km south of the town of Nhatrang. It is 50 to 100 meters east of Nhatrang Bay, 20 to 70 meters SW of a provincial road, and 0.5 km south of a small village, Chutt. Immediately in front of the Institute is a very small village, Cau Da. The nearest rivers are 4 km to the north and south. The LP seismometers are in a long tunnel cut through a hill at the back of the Physics building of the Institute. The SP seismometers are in a vault recently cut in the same hill, but are 50 meters closer to the sea.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
See station map. All buildings on the map are about 15 feet tall except for the Physics Lab and the Oceanographic Institute, which are approximately 50 feet tall. SE of the Institute is a 250-foot pier into Nhatrang Bay, where large ships are unloaded.
LOCAL GEOLOGY:

The local geology is mainly rhyolite covered by sediment. Just NW some granitic layers can be found.

STATION AND PIER CONSTRUCTION

PIERS:

See diagrams

VAULT TEMPERATURE AND HUMIDITY:

There is no environmental control at present. An air conditioner for the console and recording room will be installed at a later date. No seasonal temperature fluctuations are expected: the lowest average winter temperature is 20°C, and the highest average summer temperature is 30°C. This seasonal change should not interfere with instrument operation. No wide daily temperature fluctuations are expected. Humidity conditions are generally quite good in all instrument rooms.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 50000
SP N-S: 100000
SP E-W: 1000000
LP Z: 1500
LP N-S: 1500
LP E-W: 1500

None of the systems could operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 0.25 to 0.5 sec

AVERAGE AMPLITUDES: 0.3 μ (approx.)

REMARKS: Microseismic activity is greatest from December to March. Microseisms are greater in the vertical plane. Other natural seismic disturbances are weak.
TOP VIEW OF CONSOLE AND RECORDING ROOM. NOTE: Galvo pier supports are separated from floor and down to bedrock.
TOP VIEW OF LP PIER IN TUNNEL. NOTE: The tunnel floor is laid with brick.
TOP VIEW OF WORLD ARRAY SP VAULT
CROSS SECTION OF SP VAULT — LOOKING NORTH
SP Vault
LP SEISMOMETERS

RECORDING ROOM
MAN-MADE NOISE:

FROM THE SEISMOmeter VAULT:

The nearest railroad is 4 km
The nearest highway is 20 meters (LP) and 70 meters (SP)
The nearest river is 4 km
The ocean is 100 meters (LP) and 50 meters (SP) away

REMARKS: The only man-made disturbance that might affect the SP's is the nearby car traffic. But this seems to be overshadowed by the high microseismic activity in this area. The Vietnamese Air Force practices bombing and strafing on an island about 6 km from the station, but this does not seem to affect the SP's. There are occasional disturbances that resemble T-waves, probably caused by the motion of nearby navy ships.

OTHER INSTRUMENTS IN OPERATION:

Existing instruments consist of a system of 3-component, short-period electromagnetic seismographs of French design. Instrument constants are as follows:

Seismometer period: 1 sec; galvanometer period: 0.45 sec; Magnification: Horizontal = 70000, Vertical = 100000 (winter); Horizontal = 70000, Vertical = 200000 (summer).

RESEARCH PROJECTS IN PROGRESS:

1. Study of core waves from South Pacific earthquakes (with European data)
2. Study of T-waves from Philippine earthquakes
3. Study of local reflection waves
STATION FACILITIES

STATION: Nana, Peru

STATION DIRECTOR: Dr. Alberto A. Gieseke

TELEPHONE NUMBER: 32762

STATION ABBREVIATION: NNA

MAILING ADDRESS:
Technical Director
Seismological Division
Instituto Geofisico Del Peru
Apartado 3747
Lima, Peru

CABLE ADDRESS: AGI, Lima

ELEVATION: 575 meters

GEOGRAPHIC COORDINATES:
Latitude: 11° 59' 15" S
Longitude: 76° 50' 31" W

HISTORY OF STATION:
Construction of the station began in 1957 when the Instituto Geofisico built a tunnel to house a Benioff tensionometer. The tensionometer began operation in 1958. World Array equipment began operating here July 17, 1962. Dr. Paul Ledig was the first station director.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is located in the batholith region in the foothills of the Andes. It is about 30 km from the ocean and 25 km from Lima. About 1.5 km from the site is the Rimac River. Coastal tides average 80 cm.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is about 5 km from the small town of Nana and on a steep slope adjoining Union College. A highway and a railroad are 3 km east of the station, but vehicular traffic in this area is light. The largest building in the area is a six-story brewery in Nana. The adjacent valley contains numerous farms. There are two electrical power lines in the immediate area, one of which runs directly over the station. A power plant is in nearby mountains, approximately 15 km east of the station.

LOCAL GEOLOGY:
See geologic map.
PLANO TOPOGRAFICO DE LA CONCESION SOLICITADA
POR EL
INSTITUTO GEOFISICO DE HUANCAYO
84 HECTARIAS
PARA LA ESTACION Sismologica DE
NAÑA
LEGEND

<table>
<thead>
<tr>
<th>Layer</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quaternario</td>
<td>Q</td>
</tr>
<tr>
<td>Ters. Sup.</td>
<td>TTN</td>
</tr>
<tr>
<td>Ters. Inf.</td>
<td>TTP</td>
</tr>
<tr>
<td>Cret. Sup.</td>
<td>Km</td>
</tr>
<tr>
<td>Cret. Med.</td>
<td>KI</td>
</tr>
<tr>
<td>Jur. Med.</td>
<td>Jm</td>
</tr>
<tr>
<td>Permiano</td>
<td>P₂</td>
</tr>
<tr>
<td>Dev. Ord.</td>
<td>P₃</td>
</tr>
<tr>
<td>R. Vol Ac</td>
<td>λ</td>
</tr>
<tr>
<td>R. Vol Bas</td>
<td>δ</td>
</tr>
<tr>
<td>R. Int. Ac</td>
<td>γ</td>
</tr>
<tr>
<td>R. Int. Bas</td>
<td>σ</td>
</tr>
</tbody>
</table>

GEOLOGIC MAP

NNA-3
STATION AND PIER CONSTRUCTION

PIERS:

The seismometer piers are built in an existing tunnel, made of concrete, and anchored in the bedrock. They are isolated from the asphalt floor which is 0.2 meters thick. The galvanometer piers are in a newly constructed building, 14 meters from the mouth of the tunnel. They are also anchored in the bedrock and isolated from the cement floor. The recording piers are not isolated from the floor of the building.

VAULT TEMPERATURE AND HUMIDITY:

No environmental control is present. There are both seasonal and daily temperature fluctuations at the station. In the tunnel the temperature and humidity remain relatively constant. Temperature has been constant in the recording room; humidity has been between 90% and 98%. The humidity may be attributed partly to the recent construction of the building, but will remain high (70%-80%) in this area. Humidity at present causes paper on the recorders to wrinkle.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 50000
SP N-S: 50000
SP E-W: 50000
LP Z: 6000
LP N-S: 6000
LP E-W: 6000

None of the systems could operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 1, 5, 6 sec

AVERAGE AMPLITUDES: 0 to 0.08 μ

REMARKS: Amplitude fluctuations seem to be associated with weather conditions, though there has been very little study of the origin of microseisms at this station. The normal microseisms on the records could be caused by the wave action on the coast 24 km from the station. Other natural seismic disturbances recorded are local earthquakes.
NANA SEISMOGRAPH STATION
Lima—Peru
Date: June, 1962
Station & Vault

Seismometer Room
MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:
   The nearest railroad is 3 km
   The nearest highway is 3 km
   The nearest river is 1.5 km

OTHER INSTRUMENTS IN OPERATION:
   A Benioff tensionometer is located in the tunnel.

RESEARCH PROJECTS IN PROGRESS:
   None
STATION FACILITIES

STATION: Nurmijarvi, Finland
STATION DIRECTOR:
    Dr. Eijo Vesanan
TELEPHONE NUMBER:
    665782

STATION ABBREVIATION: NUR
MAILING ADDRESS:
    Seismological Laboratory
    Sinebrychoffink 15 A 28
    Helsinki, Finland

CADLE ADDRESS:
    Seismo
    Helsinki

ELEVATION: 102 meters

GEOGRAPHIC COORDINATES:
    Latitude: 60° 30' 30" N
    Longitude: 24° 39' 7" E

HISTORY OF STATION:
    The station at Nurmijarvi began operations in 1957 during the IGY. Dr. Vesanan has always been the station director. World Array equipment began operating here July 31, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
    The station is about 50 km NW of Helsinki, on the western shore of Lake Saaksjarvi, in a relatively dense forest. The surface is hilly with 75 to 100 feet of relief. There are no cities or rivers in the area.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
    There are no buildings or centers of activity near the station.

LOCAL GEOLOGY:
    The Nurmijarvi station lies within the Svecofennidic schist belt of southern Finland. The bedrock under the station is pyroxene gneiss of the Precambrian age. The bedrock surface is irregular and folded. Outcrops of granite and schist cover large portions of the area. Many of these outcrops show large scratches on their surface, a result of the ice movements during the ice ages. The topsoil cover varies from 0 to possibly 10 meters in some of the valleys. Most of the relatively flat areas were once shallow lakes. There are no sedimentary formations in this part of Finland.
STATION AND PIER CONSTRUCTION

PIERS:
The piers for the seismometers are L-shaped and are constructed of concrete and isolated from the vault floor by a 2-inch gap filled with foam rubber insulation. The seismometer piers are bonded into the pyroxene gneiss bedrock. The vault has a single galvanometer pier of similar construction about 3 feet above floor level. About two-thirds of the galvanometer pier is resting on the bedrock, which dips to the SW, making full support of this pier impossible. A second galvanometer pier in the recording room is not used. The recorders are sitting on a concrete shelf which is closed on both ends and one side.

VAULT TEMPERATURE AND HUMIDITY:
The control room and office will be heated in the winter, which should help to maintain a relatively even temperature in the seismometer and recording rooms the year round. Some seasonal variation is expected unless controlled heating is used. Daily temperature fluctuations are very small. Relative humidity in the vault is approximately 90%; the highest humidity should occur during spring thaws and summer.

STATION FACILITIES

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>50000</td>
</tr>
<tr>
<td>SP N-S</td>
<td>50000</td>
</tr>
<tr>
<td>SP E-W</td>
<td>50000</td>
</tr>
<tr>
<td>LP Z</td>
<td>3000</td>
</tr>
<tr>
<td>LP N-S</td>
<td>3000</td>
</tr>
<tr>
<td>LP E-W</td>
<td>3000</td>
</tr>
</tbody>
</table>

None of the systems could operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 4 to 5 sec

AVERAGE AMPLITUDES: Not given

REMARKS: Few studies of microseismic activity have been made. There are seasonal amplitude fluctuations, with maximum amplitudes recorded in January and February. Microseismic activity is least in June, July, and August. There are several earthquakes in north-central and NE Finland each year.
GENERALIZED CROSS SECTION OF VAULT
STATION AT NURMIJARVI, FINLAND
MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 2 km
The nearest highway is 1 km (light traffic)
The nearest river is 8 km

REMARKS: Explosions in the SE section of Finland are occasionally recorded. There are almost no other man-made noises at this location.

OTHER INSTRUMENTS IN OPERATION:

(1) A microbarograph and magnetic and ionospheric equipment
(2) A 3-component Nurmia seismograph system with constants:

\[ Z: T_o = 1.0 \text{ sec} \]
\[ N-S, E-W: T_o = 0.5 \text{ sec} \quad T_g = 1.1 \text{ sec} \]

RESEARCH PROJECTS IN PROGRESS:

Refraction surveys to determine the crustal thickness across southern Finland are being conducted.
STATION Facilities

STATION: Ogdensburg, New Jersey
STATION ABBREVIATION: OGD

STATION DIRECTOR:
Dr. Maurice Ewing

MAILING ADDRESS:
Lamont Geological Observatory
Torrey Cliff
Palisades, N. Y.

TELEPHONE NUMBER:
Elmwood 9-2900 (Palisades)
Vandyke 7-3488 (Ogdensburg)

CABLE ADDRESS:
Same as mailing address

GEOGRAPHIC COORDINATES:
Latitude: 41° 4' N
Longitude: 74° 37' W

ELEVATION:
-367.5 meters

HISTORY OF STATION:
World Array equipment began operating at this station on December 12, 1961.

STATION Environment

LOCAL GEOGRAPHY:
The observatory is located 540 meters beneath the floor of the Wallkill River valley and
0.8 km from Ogdensburg.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The main shaft of the New Jersey Zinc Mine is about 1800 feet from the station. There are
two crushers on the surface and one in the mine.

LOCAL GEOLOGY:
The observatory is located in a dolomitized white marble (Precambrian). Between the north
and east branches of the station the rock is cut by a vertical fault (NE to SW) with about 330
meters of displacement.
SEGMENT OF U. S. G. S. TOPOGRAPHIC MAP OF THE FRANKLIN,
NEW JERSEY, QUADRANGLE
LEGEND

CO: Cambro-Ordovician Sediments
fb: Franklin Marble
bi: Biotite Gneiss
mi: Microcline Gneiss
wb: Wildcat Marble
Lo: Losee Gneiss
ol: Oligoclase Gneiss

GEOLOGICAL AND STRUCTURAL MAP OF THE FRANKLIN-Sterling AREA
STATION AND PIER CONSTRUCTION

PIERS:
LP piers are constructed of cement laid on top of limestone and are isolated from the floor, but not the wall. The SP piers are on a cement floor over a railroad track and a dirt floor. They are about 3 feet above the limestone.

VAULT TEMPERATURE AND HUMIDITY:
No environmental control is present. Since the station is 355 meters below the ground level, temperature is constant. In the instrument rooms humidity remains 85%-90%.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:
SP Z: 100000
SP N-S: 100000
SP E-W: 100000
LP Z: 750
LP N-S: 750
LP E-W: 750

None of the systems can operate at increased magnification.

BACKGROUND AND NOISE:
PERIODS OF PREDOMINANT MICROSEISMS: 3 and 6 sec
AVERAGE AMPLITUDES: Not given
REMARKS: Microseismic activity is greatest in the autumn.

MAN-MADE NOISE:
FROM THE SEISMOMETER VAULT:
The nearest railroad is 1850 feet
The nearest highway is 2000 feet
The nearest river is 1850 feet

REMARKS: The other noise sources are rock crushers in and near the mine, a rock quarry about 8 km away, and reaction motors 32 km away.
OGDensburg Observatory

Scale: 100 ft

100 E
2900 N

100 E
3200 N

19° 0.5'

Mine North

Strain Gauge

Ogdenburg Observatory

Z Strain

OGDensburg Observatory
OTHER INSTRUMENTS IN OPERATION:
   3 Willmore and 3 Hall-Sears seismographs
   1 microbarograph
   3 quartz strain meters
   2 quartz tilt meters
   10 Varian recorders
   1 gravimeter
   3 tdemeters
   3 earth current recorders

RESEARCH PROJECTS IN PROGRESS:
   (1) Earth current studies
   (2) Gravimeter studies for tides and earthquakes
   (3) Study of high frequencies in the mine
STATION FACILITIES

STATION: Ponta Delgada, Azores

STATION DIRECTOR:
Dr. A. A. Mendonca - Dias

TELEPHONE NUMBER:
24147

GEOGRAPHIC COORDINATES:
Latitude: 37° 44.6' N
Longitude: 25° 30.7' W

STATION ABBREVIATION: PDA

MAILING ADDRESS:
Observatorio Atolão Chaves
Ponta Delgada

CABLE ADDRESS:
Not given

ELEVATION:
34.5 meters

HISTORY OF STATION:
World Array equipment began operating at this station on March 2, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is located on the grounds of the Observatorio Chaves in NE Ponta Delgada. It is approximately 0.8 km from the shoreline of the island.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The nearest center of activity is the city street, approximately 750 feet from the vault, on which the observatory is located. Traffic is light.

LOCAL GEOLOGY:
San Miguel, the island upon which the station is located, is still volcanically active. The station itself is on volcanic ash and scoria.

STATION AND PIER CONSTRUCTION

PIERS:
The vault is constructed of two layers of concrete separated by a layer of cork. The concrete piers are sunk one meter into the volcanic bed and are isolated from the vault by 6 inches of loose sand. Cables pass through conduits attached to the ceiling and through holes drilled in the walls. Neither the galvanometers nor the seismometers are attached to the piers.
VAULT HUMIDITY AND TEMPERATURE:

There is no temperature control in the instrument rooms. Temperature in the Azores varies no more than 10°C; January is the coldest month, July the warmest. Vault temperature will not vary over 3°C. Humidity in the vault is always high, 70% to 100%. It is highest in July, lowest in October.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z: 6250</td>
<td>12500</td>
</tr>
<tr>
<td>SP N-S: 6250</td>
<td>12500</td>
</tr>
<tr>
<td>SP E-W: 6250</td>
<td>12500</td>
</tr>
<tr>
<td>LP Z: 750</td>
<td>1500</td>
</tr>
<tr>
<td>LP N-S: 750</td>
<td>1500</td>
</tr>
<tr>
<td>LP E-W: 750</td>
<td>1500</td>
</tr>
</tbody>
</table>

The LP Z systems could operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 3 to 4 sec

AVERAGE AMPLITUDES: Not given

REMARKS: The 3-second background, associated with ocean waves, is much greater in the winter than in the summer. The LP (horizontal) 30- to 60-second background seems to be associated with wind. The Azores have several volcanoes still active. The island of San Miguel is still active in secondary volcanism, with geysers and hot springs abundant.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest highway is 750 feet

There are no railroads, dams, or rivers in this area

REMARKS: Natural background noise obscures any man-made noise in the area.
OTHER INSTRUMENTS IN OPERATION:

No other seismic equipment is in operation. The observatory has meteorological instruments, and a gravity meter is to be installed.

RESEARCH PROJECTS IN PROGRESS:

Velocity studies of seismic waves in the volcanic crust are planned.
STATION FACILITIES

STATION: Port Moresby, New Guinea

STATION DIRECTOR:
Mr. J. A. Brooks

STATION ABBREVIATION: PMG

MAILING ADDRESS:
Observer-in-Charge
Port Moresby Geophysical
Observatory
P. O. Box 323
Port Moresby
Territory of Papua and New Guinea

TELEPHONE NUMBER:
4458

CABLE ADDRESS:
Buromin Port Moresby Papua

GEOGRAPHIC COORDINATES:
Latitude: 9º 24.5' S
Longitude: 147º 9.1' E

ELEVATION:
70 meters

HISTORY OF STATION:

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
See topographic map

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located on an isolated 70-acre site about 12.8 km by road from Port Moresby. There are no large man-made structures nearby.

LOCAL GEOLOGY:
See geologic map

PMG-1
STATION AND PIER CONSTRUCTION

PIERS:
   See diagrams

VAULT TEMPERATURE AND HUMIDITY:
   Temperature can be expected to remain fairly constant at 87°F with maximum high and low temperatures within 5°F of this. If possible, one or two dehumidifiers will be operated continuously in the recording rooms. Without a dehumidifier, humidity in the instrument rooms is 95%, with no seasonal fluctuation.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:
   SP Z: 49124
   SP N-S: 50371
   SP E-W: 50245
   LP Z: 1441
   LP N-S: 1506
   LP E-W: 1536

   All LP components could operate at a magnification of 3000.

BACKGROUND AND NOISE:

   PERIODS OF PREDOMINANT MICROSEISMS: SP 1 to 2 sec
   LP 4 to 7 sec

   AVERAGE AMPLITUDES: SP 0 to 0.05 μ
   LP 0 to 0.5 μ

   REMARKS: Amplitude fluctuations are usually a function of local weather; so there is no seasonal correlation. Periods of extreme microseismic activity are rare, occurring only about once a year and lasting for a short time. Microseisms have not been correlated to any specific phenomena. Local earthquakes occur only infrequently, but seismic activity at a distance of 100 to 1000 km is great. Five to 10% of all the world’s earthquakes occur within 1000 km of Port Moresby.
CROSS SECTION

G' walls

pier

8'-0"

12" deep crushed Limestones
6" plain concrete

2 Layers 15 lb bituminous felt continuously cemented.

6" R.C. Floor

drain
EXTERNAL VIEW OF SEISMIC VAULT.
Note Rotary Cubical Quad antenna.
SHORT PERIOD SEISMOMETERS AND GALVANOMETERS

SHORT PERIOD RECORDER. Note: Table pier.
LONG PERIOD SEISMOMETERS AND GALVANOMETERS

LONG PERIOD RECORDER
MAN-MADE NOISE:

FROM THE SEISMOmeter VAULT

The nearest highway is 0.4 km (small road, little traffic)
The nearest dam is 48 km
The nearest river is 32 km

OTHER INSTRUMENTS IN OPERATION:

In operation at present are two horizontal Wood-Anderson torsion seismometers, one
Wilson-Lamison SP vertical seismometer, a hydrograph, a thermograph, two La Cour variogra-
graphs, and an ionospheric fast sweep recorder.

RESEARCH PROJECTS IN PROGRESS:

(1) Analyses of seismic waves and seismic activity in the New Guinea and Solomon Islands
region

(2) The formation, by the end of 1963, of a network of LP Z seismographs for crustal
thickness studies at several field stations
STATION FACILITIES

STATION: Pretoria, South Africa

STATION DIRECTOR:
Dr. F. C. Truter

STATION ABBREVIATION: PRE

MAILING ADDRESS:
Geological Survey
P. O. Box 401
Pretoria, Republic of South Africa

TELEPHONE NUMBER:
3-2631, Pretoria

CABLE ADDRESS:
Geologie, Pretoria

GEOGRAPHIC COORDINATES:
Latitude: 25° 45' S
Longitude: 28° 15' E

ELEVATION:
1359.5 meters

HISTORY OF STATION:
The Pretoria Station was put into operation in 1949. At first, the station operated with only a Benioff short-period vertical; shortly thereafter, two SP horizontals were added. Original instruments were replaced by the present World Array equipment on October 13, 1962. Station Directors have been Dr. L. T. Nel (1948-55) and Dr. F. C. Truter (1955- ).

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is in downtown Pretoria, approximately 0.4 km from the commercial center of the city.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located in the Geological Survey Building, directly behind the Transvaal Museum in downtown Pretoria. Many governmental buildings, apartment houses, and hotels are nearby.

LOCAL GEOLOGY:
The station is built upon a formation of shales, quartzites, and some dolomite. This is an extremely thick section, dips 25° north, and is Proterozoic in age.
LOCATION MAP OF PRETORIA AREA
GEOLOGICAL CROSS-SECTION THROUGH PRETORIA AND ENVIRONS, SHOWING POSITION OF SEISMOGRAPH STATION
STATION AND PIER CONSTRUCTION

PIERS:

The seismometer pier, an old pier extended to accommodate new instruments, and the galvanometer piers are of concrete. Piers are anchored in a tightly compacted shale and isolated from the floor. The recording piers are constructed of brick built up from the floor of the vault.

VAULT TEMPERATURE AND HUMIDITY:

There is no environmental control present. Although there is a marked seasonal temperature change in Pretoria (from average maximum 27.7°C to average minimum 15.3°C), vault temperature will not fluctuate to any marked degree. The vault is in the basement of the building, almost entirely below ground level. Humidity will be no problem in this dry climate.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 50000
SP N-S: 50000
SP E-W: 50000
LP Z: 1500
LP N-S: 1500
LP E-W: 1500

None of the systems can operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 1 and 6 sec

AVERAGE AMPLITUDES: 0 to .05 µ

REMARKS: Very little investigation of microseisms has been done at this station. Other natural seismic disturbances consist of occasional earthquakes and earth tremors from the caving in of old mines in the Johannesburg area.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 0.8 km
The nearest highway is 0.8 km
The nearest dam is 19.2 km
The nearest river is 1.6 km
Proposed Layout for New Seismic
Equipment To Be Installed in Existing
Rooms in the Basement of the
Geological Survey Building, Pretoria

Notes:
1. Existing concrete block to be roughened and
   extended as shown in hatching.
   Two additional concrete blocks 1 and 2 to
   be provided. The extension to existing block
   and the new blocks are to be founded on
   solid rock (in this case shale).
   Only manual methods of excavation may
   be used.
2. Brick stands 3 & 4 to be provided for recorders.
3. Existing window to be removed and cavity
   wall to be provided with staggered air bricks.

PRE-5
REMARKS: Since this station is located in the center of Pretoria, man-made noise is a problem. Traffic noise is present from 5 a.m. to midnight.

OTHER INSTRUMENTS IN OPERATION:
None

RESEARCH PROJECTS IN PROGRESS:
None
STATION FACILITIES

STATION: Quetta, Pakistan

STATION DIRECTOR:
Dr. A. Q. Khan

STATION ABBREVIATION: QUE

MAILING ADDRESS:
Geophysical Institute
P. O. Box 2
Quetta, W. Pakistan

TELEPHONE NUMBER:
2003 and 2339 (Residence phone 2133)

CABLE ADDRESS:
Geophysics
Quetta

GEOGRAPHIC COORDINATES:
Latitude: 30° 11.3' N
Longitude: 66° 57' E

ELEVATION:
1692 meters

HISTORY OF STATION:
From 1951 to 1954 the station was located in the Contonement area of Quetta. In 1954 it was moved to its present location. Mr. A. M. A. Lateef was station director from 1951 to 1954 and Dr. Khan has been the director since. World Array equipment began operating here on July 31, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is located on the edge of the north-south trending Chiltan mountain range, 9.6 km from the city of Quetta. Topography at this station may be classified as mountain foothills.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is isolated from most man-made structures, though there is a sanitorium about 0.8 km away. The station consists of eight single-story buildings close together.

LOCAL GEOLOGY:
The station is built on alluvium from 5 to 10 feet thick, composed of rough rock fragments and sands. Beneath the alluvium are limestone beds with intermittent ferruginous shale beds. These beds are of Cretaceous age. The geological structure of the area is very complicated. There is considerable folding and faulting. The station rests on a major fault plane.
STATION AND PIER CONSTRUCTION

PIERS:

The galvanometer pier is made of reinforced concrete and is attached to limestone 4 feet below the vault floor. The recorder pier is of stone and is attached to the vault floor. Seismometer piers are also made of stone and attached to limestone 4 to 5 feet below the vault floor. The galvanometer and seismometer piers are isolated from the vault floor by a 2- to 3-inch space. The seismometer pier isolation space is filled with sand.

VAULT TEMPERATURE AND HUMIDITY:

The only environmental control is a ventilation fan. No wide seasonal or daily temperature fluctuations are expected. Summer temperature is 71° to 73°F and winter temperature is 64° to 66°F. The vault will be slightly humid from December to March, but very dry the rest of the year.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>SP Z:</th>
<th>200000</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP N-S:</td>
<td>200000</td>
</tr>
<tr>
<td>SP E-W:</td>
<td>200000</td>
</tr>
<tr>
<td>LP Z:</td>
<td>3000</td>
</tr>
<tr>
<td>LP N-S:</td>
<td>3000</td>
</tr>
<tr>
<td>LP E-W:</td>
<td>3000</td>
</tr>
</tbody>
</table>

The LP Z could operate at a magnification of 6000.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 5 sec

AVERAGE AMPLITUDES: 0.05 μ

REMARKS: There are seasonal amplitude fluctuations with microseisms maximum in winter, minimum in summer. The station will probably pick up wave action from the Arabian Sea on the LP seismometers during the winter. There are frequent shallow-focus earthquakes within a 100-mile radius of the station. Frequent deep-focus earthquakes occur in the Hindu Kush region, 640 km NE of Quetta.

QUE-3
MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:
The nearest railroad is 6.4 km
The nearest highway is 6.1 km
The nearest dam is 480 km
The nearest stream is 3.2 km

REMARKS: Military blasting periodically occurs 16 km or less from the station.

OTHER INSTRUMENTS IN OPERATION:
One Wenner strong-motion, 3-component accelerograph
One Sprengnether SP Z seismograph ($T_0 = 1.8$ sec, $T_g = 1.8$ sec)
One Willmore E-W seismograph ($T_0 = 1$ sec, $T_g = 0.25$ sec)
One Sprengnether LP N-S seismograph ($T_0 = 18$ sec, $T_g = 18$ sec)

RESEARCH PROJECTS IN PROGRESS:
None
STATION FACILITIES

STATION: Quito, Ecuador  
STATION ABBREVIATION: QUI

STATION DIRECTOR:  
Dr. Luis Eduardo Mena

MAILING ADDRESS:  
Dr. Luis Eduardo Mena  
Director del Observatorio Astronómico de Quito  
Apartado 165  
Quito, Ecuador, S. A.

TELEPHONE NUMBER:  
11282

CABLE ADDRESS:  
OBSQUITO

GEOGRAPHIC COORDINATES:  
Latitude: 00° 12' 5" S  
Longitude: 78° 30' 1.8" W

ELEVATION:  
2837 meters

HISTORY OF STATION:

The station was founded in 1873. Directors have been as follows:

Juan Bautista Menten (1873-82)  
Guillermo Vickman (1887-95)  
Augusto Martinez (1895-1900)  
Francisco Gonnelliat (1900-05)  
Felipe Lagrula (1906-07)  
Abelardo Iturralde (1908-11)  
Luis G. Tufino (1911-28)  
Nicolas G. Martinez (1929-34)  
Juan Odermat (1935-49)  
L. Eduardo Mena (1950-55)  
Alfredo Schmitt (1955-58)  
L. Eduardo Mena (1958- )

World Array equipment began operating at this station on March 1, 1983.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:

The seismological station is located on the campus of the Universidad Central, near the NW edge of the city of Quito. There are no major rivers nearby. The station site is near the
bottom of the eastern slope of the mountains directly west of the city. Quito is situated slightly further down the slope and on the plain at the bottom, south and east of the station.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:

The nearest building and several small roads are about 200 meters away. A main road is 0.8 km away. Students walk near the vault when going from one main campus building to another.

LOCAL GEOLOGY:

The foundation for the seismometer piers is hardpan. Local surface formations are layers of sand and clay. The depth to the bedrock in the immediate area is unknown, but may be from 50 to 100 meters.

STATION AND PIER CONSTRUCTION

PIERS:

See enclosed station construction diagram. Seismometer piers extend to a depth of two meters and rest on hardpan.

VAULT TEMPERATURE AND HUMIDITY:

Temperature in the instrument rooms will probably correspond to the temperature outside, which ranges from 6º to 25ºC. There are no seasonal temperature changes; maximum and minimum temperature may occur at anytime during the year. A small electric heater operates continuously in the recording room, causing temperature there to be slightly higher than in the rest of the vault. Humidity in the instrument rooms is very high, averaging 75%, and corresponds to the humidity outside. There are seasonal humidity fluctuations, from 63% to 81%.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 3125
SP N-S: 3125
SP E-W: 3125
LP Z: 1500
LP N-S: 1500
LP E-W: 1500

The LP Z could operate at increased magnification.
LOCATION MAP OF QUITO STATION, ECUADOR
GEOLOGIC MAP OF ECUADOR
BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 0.2 to 0.5 sec (SP)
6 sec (LP)

AVERAGE AMPLITUDES: $3 \times 10^2 \mu$ (SP)
$9 \times 10^2 \mu$ (LP)

REMARKS: There are no seasonal amplitude fluctuations. The primary cause of micro-
seismic activity at this station is nearby traffic, which results in daily variations. The only
natural seismic disturbances are local earthquakes three or four times per year.

MAN-MADE NOISE:

FROM THE SEISOMETER VAULT:

The nearest railroad is 6 km
The nearest highway is 1 km
The nearest river is 3 km (very small)

REMARKS: Noise on the SP records during the day is caused by traffic and students
walking near the vault. Pulses are registered on the LP records from the same sources.

OTHER INSTRUMENTS IN OPERATION:

(1) 2 Mainka seismographs (mechanical registration, paper recording)
Components: N-S, E-W; Mass: 768 kg; Period: 6 sec; Magnif: 200

(2) 3 Sprengnether electromagnetic seismographs (photographic recording)
Components: N-S, E-W, Z; Period: 1.5 sec; Magnif: 3000

(3) 1 Montana-type accelerograph

(4) 2 Bosch seismographs (mechanical registration, paper recording)

(5) 1 radio receiver

(6) 1 chronograph

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Rabaul, New Guinea

STATION ABBREVIATION: RAB

STATION DIRECTOR:
J. H. Latter, Vulcanologist

MAILING ADDRESS:
Vulcanological Observatory
Box 16
Rabaul, Territory of Papua and New Guinea

TELEPHONE NUMBER:
2162

CABLE ADDRESS:
Vulcan Rabaul

GEOGRAPHIC COORDINATES:
Latitude: 4° 11' 33" S
Longitude: 159° 10' 16" E

ELEVATION:
181.2 meters

HISTORY OF STATION:
World Array equipment began operating here March 10, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is on a narrow ridge on the south side of Rabaul. A succession of narrow ridges on the north side leads down to the sea about 3000 yards away. To the elevations NE, rise steeply to the summit of a volcano (529.5 meters above sea level). Except at the ridge top, the ground is steeply sloped and thickly covered by undergrowth and trees.

STATION’S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is relatively isolated. The station director's house is 200 yards away from the vault. Vehicles rarely approach nearer than 200 yards. A gravel quarry, where occasional blasting takes place, is 100 yards to the south and about 550 feet below the station. A harbor with wharfage facilities and some heavy machinery is 1350 yards to the south. The town power station is 1100 yards SW. The main part of the town of Rabaul is over 1000 yards distant.
TOPOGRAPHIC MAP OF RABAUL AREA
LOCAL GEOLGY:

The station is on the north side of the Blanche Bay Caldera. The Caldera wall is composed of beds of pumice and tuff, with occasional beds of agglomerate and basalt. A few thermal areas exist in the floor of the caldera and craters of two dormant volcanoes on the south and east sides of the caldera. The seismograph piers are embedded in basalt about 4 1/2 feet below the vault floor.

STATION AND PIER CONSTRUCTION

PIERS:

The instrument cellar is 25 feet long, 15 feet wide, and 9 feet deep, and lined with concrete. The roof of the cellar forms portions of the floor of the above building. The seismometer pier is 13 feet long, 4 feet wide, and 32 inches high. It extends through the floor 3.5 feet and rests on basalt. The galvanometer pier is 11 feet 6 inches X 4 feet X 32 inches and also extends through the floor to the basalt. Both piers are constructed of concrete and separated from the floor by 3 inches of soft dirt. The recorder piers are on the concrete floor. The heater and calibration wires run from the console around the top of the room and down to the seismometer pier. The power cables of the recorders run along the ceiling through a curtained dark room, then down through conduits to the recorder piers and recorders.

VAULT TEMPERATURE AND HUMIDITY:

Temperature in this area varies only from 70° to 90°F. There is an air conditioner to maintain temperature within the laboratory at approximately 75°. It has been adjusted to give as low humidity as possible. This varies from 35% to 50% depending upon the number of people and the amount of activity in the room.
HORIZONTAL SCALE IN MILES
STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 6250  
SP N-S: 6250  
SP E-W: 6250  
LP Z: 750  
LP N-S: 750  
LP E-W: 750

The LP Z and SP Z systems could operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 1 to 2 sec

AVERAGE AMPLITUDES: Not given

REMARKS: Amplitude fluctuations are greatest between November and April. The main microseismic activity seems to be associated with high winds. There is no direct correlation between high seas and microseisms. The microseisms affect the horizontal instruments more than the vertical. No volcanic activity is present in this area. Local earthquakes are quite common with many minor tectonic shakes daily.

MAN-MADE NOISE:

FROM THE SEISOMETER VAULT:

The nearest highway is 0.8 km
The nearest river is 16 km
There are no railroads or dams on the island

REMARKS: As noted above, a gravel pit approximately 2000 feet from the observatory has intermittent blasting and quarrying. A power station is about 1.2 km from the station and harbor facilities are approximately 1.6 km away.

OTHER INSTRUMENTS IN OPERATION:

Seismographs: (1) Benioff Z (1.26), N-S (1.44), E-W (1.45)  
(2) Benioff Z (.35), N-S (.25), E-W (.29)  
(3) Omori N-S (3.6), E-W (3.8)

Also in operation is a Benioff vertical #1051 and Helicorder which provides visual data in the office.

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Rapid City, South Dakota

STATION DIRECTOR:
Dr. E. Tullis

STATION ABBREVIATION: RCD

MAILING ADDRESS:
Dr. Edward L. Tullis, Chairman
Dept. of Geology & Geological Engineering
School of Mines & Technology
Rapid City, South Dakota

TELEPHONE NUMBER:
343-1600
343-1601
Area Code: 605

CABLE ADDRESS:
Same as mailing address

GEOGRAPHIC COORDINATES:
Latitude: $44^\circ\ 4'\ 30''\ N$
Longitude: $103^\circ\ 12'\ 30''\ W$

F ELEVATION:
979.5 meters

HISTORY OF STATION:
World Array equipment began operating here on December 15, 1961.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
See topographic map

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located on the edge of the campus. It is approximately 500 feet to the nearest buildings.
LOCAL GEOLOGY:

<table>
<thead>
<tr>
<th>Rock Type</th>
<th>Thickness (feet)</th>
<th>Depth to Bottom (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shale</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Sandstone</td>
<td>45</td>
<td>645</td>
</tr>
<tr>
<td>Shale</td>
<td>120</td>
<td>765</td>
</tr>
<tr>
<td>Sandstone</td>
<td>100</td>
<td>865</td>
</tr>
<tr>
<td>Shale</td>
<td>100</td>
<td>965</td>
</tr>
<tr>
<td>Shale/Sandstone</td>
<td>120</td>
<td>1085</td>
</tr>
<tr>
<td>Siltstone</td>
<td>350</td>
<td>1435</td>
</tr>
<tr>
<td>Limestone</td>
<td>50</td>
<td>1485</td>
</tr>
<tr>
<td>Shale</td>
<td>130</td>
<td>1615</td>
</tr>
<tr>
<td>Shale/Limestone/Sandstone</td>
<td>650</td>
<td>2215</td>
</tr>
<tr>
<td>Limestone/Dolomite</td>
<td>350</td>
<td>2615</td>
</tr>
<tr>
<td>Sandstone</td>
<td>100</td>
<td>2715</td>
</tr>
</tbody>
</table>

STATION AND PIER CONSTRUCTION

PIERS:

See diagram

VAULT TEMPERATURE AND HUMIDITY:

Environmental control consists chiefly of thermostatically controlled electric heaters. The fresh air ducts have been closed to stabilize the temperature and keep light out of the recording room. There are wide seasonal temperature fluctuations at this location (from -20°F to 100°F). January and February are the coldest months, July the hottest. Vault temperatures, however, should not vary over 15°F. Vault humidity will be approximately the same as the humidity outside the station, averaging 20% yearly.
CROSS-SECTION OF RAPID CITY, SOUTH DAKOTA PIER CONSTRUCTION
RAPID CITY VAULT LAYOUT
STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 25000 or 50000
SP N-S: 25000 or 50000
SP E-W: 25000 or 50000
LP Z: 750 or 1500
LP N-S: 750 or 1500
LP E-W: 750 or 1500

None of the systems can operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 0.15 to 0.5 sec and 6 sec

AVERAGE AMPLITUDES: 0.01 to 0.04 μ

REMARKS: High winds, which are common, seem to be the only factor in amplitude fluctuations of the natural background. As for other natural seismic disturbances, the Black Hills are thought to be mildly seismic; regional earthquakes, mostly from Montana, are common; and a 30- to 60-second disturbance is superimposed on the 6-second background during windy weather.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 1300 feet
The nearest highway is 1100 feet
The nearest dam is 22.4 km
The nearest river is 1500 feet

REMARKS: Highway and campus traffic is very heavy except between midnight and 6 a.m. Switching and through railroad traffic is present at all times. Since these factors limit instrument magnification, the systems are probably not affected by any other noise.

OTHER INSTRUMENTS IN OPERATION:

None

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Riverview, Australia

STATION DIRECTOR:
A. Fynn, S. J.

STATION ABBREVIATION: RIV

MAILING ADDRESS:
Riverview Observatory
Riverview College Observatory
Riverview, (Sydney), N.S.W.
Australia

TELEPHONE NUMBER:
JB 2339

CABLE ADDRESS:
Not given

GEOGRAPHIC COORDINATES
Latitude: 33° 40' 45.7" S
Longitude: 151° 9' 30" E

ELEVATION:
25 meters

HISTORY OF STATION:
Succession of directors is as follows:
Dr. F. E. Pigot, S. J. (1908-1929)
W. T. O'Leary, S. J. (1929-1938)
D. J. K. O'Connell, S. J. (1938-1952)
T. N. Burke-Caffney, S. J. (1952-1958)
A. Fynn, S. J. (1958-)

World Array equipment began operating at this location on December 21, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The observatory is in a residential suburb of metropolitan Sydney, approximately 4.8 km from downtown Sydney. Local topography is hilly. The valley bottoms are tidal estuaries, one of which is 400 feet east of the observatory. The observatory is 11.2 km inland from the Pacific Ocean.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The observatory is on a college campus, about 300 feet from the closest large building. The nearest building within the observatory grounds is a small shed about 40 feet north. The administration building is 90 feet east, but is not a noise source. The observatory library is above the vault, but it is not a center of activity. There are medium-sized trees nearby, and the grounds are surrounded by open lawn.
LOCAL GEOLOGY:

The vault is on solid Triassic Hawkesbury sandstone. This is a sandstone of remarkably uniform character, 278 meters thick. It is underlain by the Triassic Narrabeen formation, 600 meters of sandstone and shale. This in turn is underlain by 1500 meters of Permo-Carboniferous sediments.

STATION AND PIER CONSTRUCTION

PIERS:

The seismometer and galvanometer piers are constructed of concrete and isolated from the vault floor by a 2-inch gap which is topped with tar. These piers extend below the vault floor approximately 18 inches and rest on the Hawkesbury sandstone bedrock.

VAULT TEMPERATURE AND HUMIDITY:

The vault has an inner ceiling near ground level with about 2 feet of air space above, which, in turn, is covered by insulation a foot or more thick. As a result, the vault has a fairly constant temperature, about 66°F during summer and 60°F during winter. Wide temperature fluctuations are expected outside the vault. During January and February up to 100°F may be recorded and during July and August near freezing temperatures may occur. Although humidity is high enough to cause paper expansion, no other problems are expected. The recorders, console, and seismometers are all expected to experience the same humidity, ranging from approximately 60% in October to 75% in May. Condensation in the vault is likely. After the vault has been in constant operation, it should become somewhat less humid.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>12500</td>
</tr>
<tr>
<td>SP N-S</td>
<td>12500</td>
</tr>
<tr>
<td>SP E-W</td>
<td>12500</td>
</tr>
<tr>
<td>LP Z</td>
<td>750</td>
</tr>
<tr>
<td>LP N-S</td>
<td>750</td>
</tr>
<tr>
<td>LP E-W</td>
<td>750</td>
</tr>
</tbody>
</table>

During times of exceptionally low microseismic activity all systems could operate at increased magnification.
GEOLOGIC CROSS SECTIONS OF THE SIDNEY AREA

Section AB is NW-SE, 15 mi north of the Station
Section CD is NE-SW, 15 mi west of the Station
Nearest position of the station is indicated

Reference
VAULT AND RECORDING ROOM
AERIAL PHOTO OF SIDNEY N.S.W. STATION
BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 1.5 sec and 4 sec

AVERAGE AMPLITUDES: 0.2 \( \mu \) and 4 \( \mu \) (0 to peak)

REMARKS: Microseismic activity is greater in the winter (June through August) than in summer (January through March). The level varies greatly from day to day. In addition there is an SP background, designated microseisms, having a period of 0.5 seconds. This was calculated on some test records to have an amplitude of 0.05 \( \mu \). Another disturbance, having a 10- to 30-second period, has been recorded (mainly on horizontals) in the past. It occurred between 2 a.m. and noon, and its cause remains undetermined. Other natural seismic disturbances in this region are limited to possible noise from wave action.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:
- The nearest railroad is 3.2 km
- The nearest highway is 1.6 km
- The nearest dam is 32 km
- The nearest river is 400 feet (a tidal estuary)
- The Pacific Ocean is 11.2 km

REMARKS: Riverview College is surrounded by a residential area with light traffic constituting the most regular source of man-made noise. This is a relatively new suburban area where construction of homes can be expected to produce noise from time to time. Such noise is negligible compared to the natural background noise.

OTHER INSTRUMENTS IN OPERATION:

1. Wiechert vertical (period 4.3 sec)
2. Two Mainka horizontals (period 8.5 sec, magnification 150)
3. Three-component Galitzin (periods 11 and 12 sec)
4. Sprengnether vertical (period 1.6 sec, magnification 3000)

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Scott Base, Antarctica

STATION DIRECTOR:
Dr. F. F. Evison

STATION ABBREVIATION: SBA

MAILING ADDRESS:
Seismological Observatory
Geophysics Division
D.S.I.R.
156 The Terrace
Wellington, New Zealand

TELEPHONE NUMBER:
None

CABLE ADDRESS:
SEISMO
Wellington

GEOGRAPHIC COORDINATES:
Latitude: 77° 51' S
Longitude: 166° 46' E

ELEVATION: 15 meters

HISTORY OF STATION:
Seismic recording commenced in the summer of 1957 under the direction of Mr. Hayes of the Seismological Observatory in Wellington. Dr. F. F. Evison succeeded Mr. Hayes in 1960. World Array equipment began operating here in March, 1963.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
See topographic map

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
Not given

LOCAL GEOLOGY:
The station is located on the Ross volcanics. The seismometers are on top of permafrost scoria.
STATION AND PIER CONSTRUCTION

PIERS.

Seismometer piers consist of concrete poured on permafrost and are not isolated from the building. All interior cabling is attached to walls with installed staples. Exterior cabling is run through the floor at the base of the LP galvanometer pier to the eave of the building. From there it is suspended 100 feet to an antenna pole, then run to a shallow ditch and to the seismometer building.

VAULT TEMPERATURE AND HUMIDITY:

There is no environmental control in the seismometer building. Seasonal temperature fluctuations from -50°C to 5°C will occur in the seismometer room, where temperature corresponds to that outside. Recording room temperature is regulated by thermostatically-controlled hot water and electric heat, and little temperature variation is expected in the recording and control rooms. Humidity is low at all times.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

Not given

BACKGROUND AND NOISE:

Not given

MAN-MADE NOISE:

Not given

OTHER INSTRUMENTS IN OPERATION:

Weather, magnetic, and ionospheric equipment

RESEARCH PROJECTS IN PROGRESS:

Not given
SEISMOMETER VAULT SCOTT BASE, ANTARCTICA
SCOTT BASE GEOPHYSICS LABORATORY, ANTARCTICA
STATION FACILITIES

STATION: State College, Pennsylvania
STATION DIRECTOR: B. F. Howell, Jr.
STATION ABBREVIATION: SCP
MAILING ADDRESS:
Geophysical Laboratory
220 Mineral Sciences Bldg.
University Park, Pa.

TELEPHONE NUMBER:
814-UN5-6821
CABLE ADDRESS: Not given

GEOGRAPHICAL COORDINATES:
Latitude: 40° 48' 35.5'' N
Longitude: 77° 52' 9.8'' W
ELEVATION: 353 meters

HISTORY OF STATION:
World Array equipment began operating here on January 26, 1962

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
See topographic map

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located in a temporary pier room in one of the college buildings, but is isolated from the main areas of campus activity.

LOCAL GEOLOGY:
The station is in the Valley and Ridge Province of the Appalachian Mountains and is on Ordovician Stonehenge limestone.
STATION AND PIER CONSTRUCTION

PIERS:

The piers are slabs of concrete poured upon the original floor of the building. They are not isolated from the floor and do not extend to the bedrock. The original floor is 6 inches of concrete lying upon 8 inches of packed gravel and an unknown amount of overburden, which may be 20 feet deep.

VAULT TEMPERATURE AND HUMIDITY:

Heater-type fans, controlled by a thermostat, are present. Since the fans interfere with the LP system, however, they are not operated. Daily temperature fluctuations in the instrument room should not exceed 5°F. Seasonal temperature fluctuations are expected, with low temperatures (30°F to 45°F) in December and January and high temperatures (65°F to 80°F) in July and August. It will probably be dry in the winter and humid in the summer.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 50000
SP N-S: 50000
SP E-W: 50000
LP Z: 750
LP N-S: 750
LP E-W: 750

The LP Z could be operated at a magnification of 1500. The entire SP group can possibly operate at 100000 in the summer, since, according to reports, microseisms are greatly reduced then.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: Not given

AVERAGE AMPLITUDES: Not given

REMARKS: The greatest amplitude fluctuations occur during the winter; microseismic activity is least during the summer. Microseismic activity is apparently related to storm fronts moving from the Lawrence Straits and Hudson Bay regions. A period of 7 seconds has been recorded. There are no other significant natural seismic disturbances in this area.
MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 5.1 km

The nearest highway is 1.6 km

There are no dams or rivers in this area

REMARKS: Other noise sources are the activities of building personnel: automobile driving, door slamming, walking, and equipment moving. This will more than likely disturb the SP system only.

OTHER INSTRUMENTS IN OPERATION:

Also in operation at this station is a three-component seismograph system constructed by station personnel:

<table>
<thead>
<tr>
<th>Component</th>
<th>Period</th>
<th>Galvanometer Type</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-S</td>
<td>11 sec</td>
<td>L &amp; N</td>
<td>2.3 sec</td>
</tr>
<tr>
<td>E-W</td>
<td>14 sec</td>
<td>L &amp; N</td>
<td>3.65 sec</td>
</tr>
<tr>
<td>Z</td>
<td>3.4 sec</td>
<td>L &amp; N</td>
<td>4 sec</td>
</tr>
</tbody>
</table>

RESEARCH PROJECTS IN PROGRESS:

(1) Refraction profile of Central Pennsylvania (extending to the Moho)
(2) Gravity survey of Central Pennsylvania
(3) Model studies of earthquake mechanisms
(4) The effect of pressure (0 to 30,000 psi) on the resistivity, porosity and permeability of some selected sandstones
(5) Investigation of iron deposits near Morgantown, Pa., using SP and resistivity methods
(6) Study of thermal properties of rock
(7) Model studies to determine depth of focus
STATION FACILITIES

STATION: Seoul, Korea

STATION DIRECTOR:
Mr. Chaepyo Cook

STATION ABBREVIATION: SEO

MAILING ADDRESS:
Central Meteorological Office
1 Songwul-Dong Sundaemoon-Ku
Seoul, Korea

TELEPHONE NUMBER:
730627

CABLE ADDRESS:
Not given

GEOGRAPHIC COORDINATES:
Latitude: 37° 34' N
Longitude: 126° 58' E

ELEVATION:
85.5 meters

HISTORY OF STATION:
The station has been in operation for 15 years. From 1945 until May, 1961, Dr. Wonchul Lee was station director. The office was then vacant until Mr. Cook became director on September 11, 1961. World Array equipment began operating here March 28, 1963.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
Large hills surround the station which sits on the crest of one of the smaller hills in this region. The Han River, wide but not very deep, is 3.2 km from the station.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located on the grounds of the Central Meteorological Office in Seoul, 3.2 km NW of the main part of the city. Various office and storage buildings, the largest of which is two stories high, surround it. Vehicular traffic near the building is rare. A streetcar line is 0.8 km away. An antenna tower is about 50 feet from the station.

LOCAL GEOLOGY:
The geology of this location is unknown.
TOPOGRAPHIC MAP SEOUL, KOREA
STATION AND PIER CONSTRUCTION

PIERS:
The piers supporting the galvanometers and seismometers are made of concrete and are isolated from the building.

VAULT TEMPERATURE AND HUMIDITY:
Environmental control consists of a kerosene heater in the console room and a dehumidifier in the recording room. The exhaust pipe from the heater runs through the recording room and supplies it with some heat. Seasonal or daily temperature fluctuations are not expected. Since the seismometer rooms are below ground level, temperature there should be very stable. Humidity in Seoul ranges from 20% to 100% and is highest during July and August. Moisture in the building has been a constant problem.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>100000</td>
</tr>
<tr>
<td>SP N-S</td>
<td>100000</td>
</tr>
<tr>
<td>SP E-W</td>
<td>100000</td>
</tr>
<tr>
<td>LP Z</td>
<td>1500</td>
</tr>
<tr>
<td>LP N-S</td>
<td>1500</td>
</tr>
<tr>
<td>LP E-W</td>
<td>1500</td>
</tr>
</tbody>
</table>

None of the systems can operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 0.6 to 0.7 sec

AVERAGE AMPLITUDES: 0.15 μ

REMARKS: Adequate information about background and noise at this location is not yet available. Earthquakes are not common in Korea, and little natural seismic disturbance is expected.
Vault

Galvanometer Room
MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

- The nearest railroad is 0.8 km
- The nearest highway is 0.8 km
- The nearest dam is 32 km
- The nearest river is 3.2 km

REMARKS: Very likely, some of the high-frequency noise visible on the SP systems is caused by streetcars which run within 0.8 km of the station.

OTHER INSTRUMENTS IN OPERATION:

Other instruments consist of 3 acceleration seismographs (mechanical). The seismometers are air damped and have a natural period of 0.08 seconds and a magnification of 200. These instruments were manufactured by the Katsujima Instrument Company in Japan. Recorders are driven by line voltage and time is supplied by a pendulum clock.

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Spring Hill, Alabama

STATION DIRECTOR:
L. J. Eisele, S. J.

STATION ABBREVIATION: SHA

MAILING ADDRESS:
Department of Physics
Spring Hill College
Mobile 22, Alabama

TELEPHONE NUMBER:
342-1541
Area Code 205

CABLE ADDRESS:
Same as mailing address

GEOGRAPHIC COORDINATES:
Latitude: 88° 8' 23.04'' W
Longitude: 30° 41' 41.12'' N

ELEVATION:
58.5 meters

HISTORY OF STATION:
Seismic recording began at this location in 1911. The first instrument was a Wiechert seismograph. Cyril Ruhlmann, S. J., was the first station director. Father Eisele has been the director since 1946. World Array equipment began operating here on April 16, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
See topographic map

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located on the campus of Spring Hill College, about 9.6 km west of downtown Mobile. The college is surrounded largely by residential areas and scattered shopping centers. The principal roads in the immediate area are Old Shell Road along the north side of the campus and McGregor Avenue to the west of the campus. A small shopping center is at the intersection of these two roads. Campus streets surround the station, except to the south. A student parking lot adjoins the station to the north, and a dormitory is about 200 feet NW.
LOCAL GEOLGY:

The station is at the eastern edge of a series of flat-topped hills west of Mobile. The altitude of this ridge, between Spring Hill and the town of Citronelle, ranges from about 200 to 300 feet. The ridge forms the drainage divide between the Escalawpa and Mobile Rivers. These hills are capped by deposits of sand, gravel, and lenticular white-to-variegated clay of the Citronelle formation of Pliocene or early Pleistocene age. Deposits in this area probably were laid down by the ancestral Alabama River. The Citronelle formation is underlain unconformably by estuarine deposits of Miocene age which consist of gray dense clay, sandy clay, fine argillaceous sand, medium to coarse sand, and gravelly sand about 300 feet thick at the base. Steep slopes are generally typical of the outcrops of Miocene deposits along the sides of the Spring Hill-Citronelle ridge.

STATION AND PIER CONSTRUCTION

PIERS:

The seismometer piers are constructed of concrete with no reinforcing bars. Galvanometer and recording piers are made of cement blocks. Because of lack of basement rock, piers were tied to the floor and walls directly, for better earth contact. The floor is 11 feet below ground level.

VAULT TEMPERATURE AND HUMIDITY:

There is a false ceiling of styrofoam in all instrument rooms. Air is circulated above to prevent moisture condensation under the roof. A dehumidifier is also present in the recording room, keeping humidity within a reasonable range. No wide seasonal temperature fluctuations are expected: a minimum of 67°F might be expected in January or February and a maximum of 75°F in August.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>SP Z:</th>
<th>6193</th>
<th>The LP Z systems could operate at increased magnification.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP N-S:</td>
<td>6222</td>
<td></td>
</tr>
<tr>
<td>SP E-W:</td>
<td>6180</td>
<td></td>
</tr>
<tr>
<td>LP Z:</td>
<td>753</td>
<td></td>
</tr>
<tr>
<td>LP N-S:</td>
<td>742</td>
<td></td>
</tr>
<tr>
<td>LP E-W:</td>
<td>738</td>
<td></td>
</tr>
</tbody>
</table>
EXISTING STRUCTURE CROSS-RULED
HEAVILY REINFORCED CONCRETE
(1/2 of Unused 210,000 Gallon Water Reservoir)

FLOOR PLAN OF SEISMIC VAULT, WORLD WIDE SEISMIC NETWORK,
SPRING HILL COLLEGE, MOBILE, ALABAMA
ELEVATION PLAN, SEISMIC VAULT, SPRING HILL COLLEGE

Fill
Grade

1'  2'' Styrofoam

7''

10'

8''

Pier

Drain

Steps: 7'' Riser
10 1/2'' Tread
Short-Period Recording System
Short-Period Seismometers
Long-Period Recording System
BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 1 and 6 sec

AVERAGE AMPLITUDES: 0.16 μ (SP)
1 μ (LP)

REMARKS: There are seasonal amplitude fluctuations. Maximum vertical activity occurs in winter (period = 2.8 sec), maximum horizontal activity in summer (period = 6 to 9 sec). High microseismic activity in this area is due primarily to the poor subsurface structure. There is no bedrock down to 2500 feet. This location is not far from the Gulf Coast, which may account for some of the noise. The instruments in operation at this station have shown considerable activity during storms and frontal movements. This activity is not as noticeable on the newer systems. Diurnal thermal effects seem to cause a great deal of drift, extremely high amplitude, and long-period pulses on the LP horizontal components. There are no other known natural seismic disturbances at this location.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 1.6 km
The nearest highway is 300 yds
The nearest dam is 12.8 km
The nearest river is 9.6 km

REMARKS: Local traffic apparently is the main cause of the LP noise.

OTHER INSTRUMENTS IN OPERATION:

A three component seismograph system is now in operation. This is a unique system employing Eisele-AC Transducer seismometers, with a visible pen recorder. This system was completely designed and built by Fr. Eisele in 1953. The vertical system has a period of 3 seconds, and the two horizontal systems have periods of 9 seconds. All have a magnification of 5000. These instruments employ an AC pickup in an AC field and are magnetically damped.

RESEARCH PROJECTS IN PROGRESS:

Instrumental research on modification of the Eisele-AC Transducer pen-recording seismometer is in progress.
STATION FACILITIES

STATION: South Pole, Antarctica

STATION DIRECTOR:
Ron Davis

STATION ABBREVIATIONS: SPA

MAILING ADDRESS:
Mr. E. E. Goodale
USARP Representative Christchurch
International Airport
Christchurch, New Zealand

TELEPHONE NUMBER:
None

CABLE ADDRESS:
Not given

GEOGRAPHIC COORDINATES:
Latitude: 90° S
Longitude: 0

ELEVATION:
2880 meters

HISTORY OF STATION:
The U. S. Coast and Geodetic Survey has had manned seismograph and geomagnetic stations at the Pole since 1956-57, when the South Pole Base was built. World Array equipment began operating here February 16, 1963.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The South Pole station is located on the Antarctic ice cap, on a flat plain extending to the horizon in all directions. The vault containing the World Array system is about 1000 feet from the base's personnel buildings and offices.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The only man-made structures nearby are the facilities of the South Pole Base. All of these buildings are beneath the snow surface, as is the World Array vault. A number of antenna towers from 40 to 50 feet high are 1000 feet or more from the vault.

LOCAL GEOLOGY:
The ice cap at this location is 2700 meters thick, and glaciologists estimate it moves about 100 feet per year.
STATION AND PIER CONSTRUCTION

PIERS:
The station's two buildings, the seismometer vault and the recording room, are adjacent. The vault is built into the snow, with its roof level with the surface. It is 12 feet by 16 feet and has a 6-foot by 8-foot pier, isolated from the floor. The pier is constructed from one layer of 6-inch by 12-inch boards which lie flat on the snow. These are covered by one layer of 4-inch by 8-inch boards, which in turn are capped by a double layer sheet of aluminum (1/4 inch). It is not a particularly good pier, and it appears to be settling slightly. The recording room is 8 feet by 20 feet and is partitioned into two sections. The smaller section (4 feet by 8 feet) contains the console. Galvanometers are located on an isolated pier (3 feet by 5 feet) constructed of two layers of 6-inch by 12-inch boards.

VAULT TEMPERATURE AND HUMIDITY:
Temperature in the seismometer vault is about -20°C. This will decrease to -40°C, possibly -50°C, during the winter. Two 150-watt light bulbs left burning in the vault may make some difference. Electric heaters in the recording room should keep temperature there constant at 5°C. All the recording equipment is on the floor where the temperature is from -5°C to -10°C. Humidity is not a problem at the Pole since it is so cold that there is virtually no moisture in the air.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>100000</td>
</tr>
<tr>
<td>SP N-S</td>
<td>100000</td>
</tr>
<tr>
<td>SP E-W</td>
<td>100000</td>
</tr>
<tr>
<td>LP Z</td>
<td>375</td>
</tr>
<tr>
<td>LP N-S</td>
<td>375</td>
</tr>
<tr>
<td>LP E-W</td>
<td>375</td>
</tr>
</tbody>
</table>

When the temperature stabilizes, all LP instruments could operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 4 sec

AVERAGE AMPLITUDES: Not given
SEISMOMETER VAULT

1/4" Aluminum Plate (2 Layers)

4" × 8" Planking

6" × 12" Planking

Cross Section
REMARKS: Adequate information on background and noise at this location is not available. In general, however, it may be said that the Antarctic continent is seismically very quiet.

MAN-MADE NOISE:

There are no railroads, highways, dams, or rivers in this area

REMARKS: Man-made noise consists of that caused by large snow tractors operating continuously during the summer months. Whenever they approach within 1000 feet of the vault, they disturb the records.

OTHER INSTRUMENTS IN OPERATION:

(1) One Benioff vertical seismograph (period: 0.74 sec)
(2) Two Wilson-Lamison horizontal seismographs (period: 3 sec)
(3) Various meteorological and atmospheric instruments

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Stuttgart, Germany

STATION DIRECTOR:
Dr. Wilhelm Hiller

STATION ABBREVIATION: STU

MAILING ADDRESS:
Landeserdbebendienst
Baden-Wurttemberg
Stuttgart-O
Richard-Wagner-Strasse 15

TELEPHONE NUMBER:
24 09 63

CABLE ADDRESS:
Not given

GEOGRAPHIC COORDINATES:

Latitude: 48° 46' 15" N
Longitude: 9° 16' 36" E

ELEVATION:
375 meters

HISTORY OF STATION:
World Array equipment began operating here on February 20, 1962

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is on a ridge SE of the large industrial city of Stuttgart. The ridge overlooks a valley in which the main part of the town is situated. A fairly large river, the Neckar, flows through Stuttgart.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located in the office building of the State Minister of Baden-Wurttemberg. There are other buildings within 150 meters and a streetcar line 500 meters away.

LOCAL GEOLOGY:
See geologic map
STATION AND PIER CONSTRUCTION

PIERS:
See station and pier diagram

VAULT TEMPERATURE AND HUMIDITY:
The temperature is about 14°C in the seismometer room and 18°C in the console and galvanometer rooms. No wide seasonal or daily temperature fluctuations are expected. Instrument room humidity is 00%, and will probably rise to 85% during the summer.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS
SP Z: 25000
SP N-S: 25000
SP E-W: 25000
LP Z: 750
LP N-S: 750
LP E-W: 750
No possible increased magnification for these systems has been reported.

BACKGROUND AND NOISE:
Not given

MAN-MADE NOISE:
Not given

OTHER INSTRUMENTS IN OPERATION:
Seismographs: (1) Two Galitzin-Willp 3-components (period 12 sec, Mag. 1260)
(2) Hiller (period 1.4 sec, Mag. 10000)
(3) Nienle horizontals (period 10 sec)
(4) Wiechert horizontals (period 1.5 sec)
(5) Wiechert vertical (period 1.06 sec)

RESEARCH PROJECTS IN PROGRESS:
Not given
STATION FACILITIES

STATION: University of Tasmania

STATION DIRECTOR:
Professor S. W. Carey

STATION ABBREVIATION: TAU

MAILING ADDRESS:
University of Tasmania
Department of Geology
Box 252C, G. P. O.
Hobart, Tasmania

TELEPHONE NUMBER:
2-7741-2

CABLE ADDRESS:
University of Tasmania
Hobart, Tasmania

GEOGRAPHIC COORDINATES
Latitude: 42° 54' 35.74" S
Longitude: 147° 19' 13.54" E

ELEVATION: 132.2 meters

HISTORY OF STATION:
The University of Tasmania seismic system was established in 1957. At present the net consists of four stations which telemeter data directly to Hobart. The World Array system is installed in a vault adjacent to the campus of the university and began operating on May 31, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
See topographic map

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The vault is approximately 0.8 km from the university campus and is completely isolated from all traffic and man-made structures. The recording room is on the ground floor of the Geology building, which is in the center of the campus and near other similar structures.

LOCAL GEOLOGY:
See geologic cross section
TOPOGRAPHIC MAP OF HOBART AREA
GEOLOGIC CROSS SECTION OF HOBART AREA
STATION AND PIER CONSTRUCTION

PIERS:

See enclosed diagrams

VAULT TEMPERATURE AND HUMIDITY:

No wide temperature changes are expected in the instrument rooms, though gradual changes may occur from season to season. A heater is currently operating in the recording room, and a dehumidifier is to be installed in the near future. Humidity is very high in the instrument rooms, probably because of their recent construction. Humidity in the recording room causes the recording paper to expand on the drums and thus change the light focus. The addition of a dehumidifier should eliminate this.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 24880
SP N-S: 25288
SP E-W: 24785
LP Z: 770
LP N-S: 760
LP E-W: 771

None of the systems could operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 1 to 2 sec (SP)

5 to 6 sec (LP)

AVERAGE AMPLITUDES: .04 μ (SP)

3 μ (LP)

REMARKS: Amplitudes fluctuate seasonally. The greatest activity is from June to September and the least is from November to February. Microseismic activity increases greatly whenever storms or frontal movements enter the area. Local earthquakes from practically all sections of the island are recorded at this station.
PLAN SEISMIC RECORDER ROOM,
BASEMENT, NEW GEOLOGY BUILDING
UNIVERSITY OF TASMANIA

Pier
Long Period Galvanometers
2" Isolation Space,
Round Floor

Pier

Triple Drum Recorder

3' 0"

Triple Drum Recorder

40-w Fluorescent
Lights

Short Period Galvanometers

Console

Light Trap

2' 0"

2' 9"

○ Red Safelights  ● 10-amp Power
Outlets  + Cable Duct
Outlet  X Switch

TAU-6
Geology Building housing the recorder room.

View showing fill covering seismic vault.
MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:
   The nearest railroad is 3.2 km
   The nearest highway is 1.6 km
   The nearest dam is 96 km
   The nearest river is 1.6 km

REMARKS: The only noticeable man-made noise results from blasting in a nearby quarry.

OTHER INSTRUMENTS IN OPERATION:
   (1) 3 Willmore SP seismometers
   (2) 1 Newstead-Watt horizontal, active electronic seismometer

RESEARCH PROJECTS IN PROGRESS:
   (1) Electronic correlation of records from telemetered stations recording on magnetic
tape (to eliminate microseisms and increase gain settings)
   (2) Study of foreshocks and local seismicity
   (3) Spectral analysis and identification of sources, with study of local station array
STATION FACILITIES

STATION: Toledo, Spain

STATION DIRECTOR:
Luis De Miguel Gonzalez-Miranda

STATION ABBREVIATION: TOL

MAILING ADDRESS:
Office of Commercial Attaché (Tol)
American Embassy
APO 285
New York, N. Y.

TELEPHONE NUMBER:
1440

CABLE ADDRESS:
None

GEOGRAPHIC COORDINATES:
Latitude: 39° 52' 53" N
Longitude: 4° 2' 55" W

ELEVATION:
480.5 meters

HISTORY OF STATION:
The old observatory was built in 1909 in Toledo. In 1933 it was moved to the present site to avoid the city noise. Directors since 1933 have been Alfonso Rey Pastor, Cifuentes Rodriguez, Juan Bonelli Rubio, and Luis De Miguel Gonzalez-Miranda, who has been director since 1960. World Array equipment began operating here April 27, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The area surrounding the station is hilly, but there are no mountains nearby. The Tajo River (18 meters deep) is 0.4 km to the south, there is a dam about 0.8 km from the site, and Toledo is 4 km away.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is on the grounds of the geophysical observatory. Activity here consists of the daily routine of the people who work at the observatory. All seismic instruments, including the standard equipment, are housed in the seismology building. The nearest building is an office and apartment building 100 meters from the station.

LOCAL GEOLOGY:
The observatory is located in the Tajo River basin. The buildings and piers rest on alluvium fill, deposited as the river changed its course. The surface is of Miocene age.
STATION AND PIER CONSTRUCTION

PIERS:

The seismometer pier is made of reinforced concrete. Its top is attached to two concrete
pillows, which extend 8 feet into the ground and are bottomed in the alluvium, since it is im-
possible to attach them to hard rock at this location. The pier is isolated from the building
and enclosed by a wall.

VAULT TEMPERATURE AND HUMIDITY:

There are no heaters or air conditioners in the building. The temperature is very stable
in the instrument rooms, between $10^\circ$ and $20^\circ$C throughout the year. A moisture-absorbing com-
 pound was placed in each of the LP seismometers because the instrument rooms are very humid,
except during the summer months.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Type</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>25100</td>
</tr>
<tr>
<td>SP N-S</td>
<td>12550</td>
</tr>
<tr>
<td>SP E-W</td>
<td>12550</td>
</tr>
<tr>
<td>LP Z</td>
<td>1530</td>
</tr>
<tr>
<td>LP N-S</td>
<td>1440</td>
</tr>
<tr>
<td>LP E-W</td>
<td>1465</td>
</tr>
</tbody>
</table>

The SP systems could possibly operate at increased magnification during the summer
months.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 5.5 to 6.5 sec

AVERAGEAMPLITUDES: 15 to 17 $\mu$

REMARKS: In the winter months amplitude is occasionally 50 $\mu$; microseismic activity is
lowest in the summer. About fifteen days out of the year microseisms of 10 to 12 sec in period
are recorded here. They are presumably caused by storms in the Atlantic Ocean, north of
England. Other natural seismic disturbances in this area are very rare. Earthquakes recorded
here occur at a great distance from Toledo.
VAULT, TOLEDO, SPAIN
MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 4.8 km
The nearest highway is 0.4 km
The nearest dam is 0.8 km
The nearest river is 0.8 km

REMARKS: Recorded noise appears to correlate with traffic along the nearby highway. A spur line serving only Toledo has an occasional train, but little of the recorded noise originates from the railroad. The river and the dam could possibly cause some of the noise. About 0.4 km south of the station trucks are loaded with dirt and rocks, which might also contribute to the background noise.

OTHER INSTRUMENTS IN OPERATION:

<table>
<thead>
<tr>
<th>Seismometers</th>
<th>Period</th>
<th>Galvo</th>
<th>Period</th>
<th>System Mag.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprengnether Z</td>
<td>1.5 sec</td>
<td>I&amp;N</td>
<td>1.5 sec</td>
<td>7000+</td>
</tr>
<tr>
<td>Sprengnether E-W</td>
<td>14 sec</td>
<td>I&amp;N</td>
<td>14 sec</td>
<td>2000±</td>
</tr>
<tr>
<td>Sprengnether N-S</td>
<td>14 sec</td>
<td>I&amp;N</td>
<td>14 sec</td>
<td>2000+</td>
</tr>
<tr>
<td>Wiechert EW&amp;NS</td>
<td>8 sec</td>
<td>Mechanical</td>
<td></td>
<td>400±</td>
</tr>
<tr>
<td>Wiechert Z*</td>
<td>2.7 sec</td>
<td>Mechanical</td>
<td></td>
<td>1500+</td>
</tr>
<tr>
<td>Wiechert E-W*</td>
<td>11 sec</td>
<td>Mechanical</td>
<td></td>
<td>700±</td>
</tr>
<tr>
<td>Wiechert N-S*</td>
<td>11 sec</td>
<td>Mechanical</td>
<td></td>
<td>700±</td>
</tr>
</tbody>
</table>

*Asterisked systems have been modified by the observatory at Toledo.

MAGNETICS

Schmidt Magnetometer
QHM Magnetometer (Horizontal)
Terrestrial Inductor—Measurement of magnetic inclination
BMZ—Vertical component

Rapid Run Magnetometers:

La Cour 180 mm/hour
Töpper 20 mm/hour

Askania (Declination, Horizontal, and Vertical) 30 mm/hour
GEOELECTRICITY

Earth current (subterranean)
Ionization (Ekert)
Ionosphere (unit is incomplete)

RESEARCH PROJECTS IN PROGRESS.

None
STATION FACILITIES

STATION: Trinidad, West Indies
STATION DIRECTOR: Dr. G. R. Robson
STATION ABBREVIATION: TRN
MAILING ADDRESS: University College of the West Indies Seismic Research Unit St. Augustine Trinidad, W. I.

TELEPHONE NUMBER: STA - 94843
CABLE ADDRESS: Seismo Trinidad

GEOGRAPHIC COORDINATES:
Latitude: 10° 39' N
Longitude: 61° 24.124' W
ELEVATION: 24 meters

HISTORY OF STATION:
World Array equipment began operating here February 27, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is located 20.8 km east of Port of Spain. Mountains up to 2000 feet, trending east to west, are immediately north. Surfaced roads are south and east. Land to the south is pasture and savannah.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located on the north edge of the university campus. A biology lab is 0.4 km west and the main campus is 1.6 km south. The station is isolated from homes and other buildings by pasture and forest land.

LOCAL GEOLOGY:
See geologic cross section
MAP OF TRINIDAD SHOWING THE LOCATION OF THE VAULT AND GEOLOGIC CROSS SECTION
N-S GEOLOGIC CROSS SECTION OF TRINIDAD

LEGEND

SCALE
10 miles

The presentation and printing of this map have been made possible through the financial contributions of the member companies of the Petroleum Association of Trinidad and Tobago.

Earlier compilations by G. P. Wall & J. G. Saukman, E. H. Cunningham-Craw, G. A. Winter, G. W. Scholtz, and A. G. A. Sulten have also been incorporated.

The eastern end of the Northern Range has been taken over from a study by R. W. Ban and that of Central Trinidad from a compilation by H. Rahn.

TRN-3
STATION AND PIER CONSTRUCTION

PIERS:

Piers are constructed of massive concrete and isolated from the floor by a 2-inch separation. Calvanometer piers extend 6 feet below the floor and are tied to decomposed phyllite. Seismometer piers extend 2 feet below the floor and are tied to fresh phyllite. Cables pass from the console room to the recording room beneath the wall through a 6-inch pipe. Cables are passed from the console room to the seismometer vault through two 1-inch conduits which are buried approximately 3 feet.

VAULT TEMPERATURE AND HUMIDITY:

There is no temperature control in either the recording room or the vault. An air conditioner is available for the recording room, but the instruments work better without it. There is no wide seasonal temperature variation: temperatures range from 60°F to 95°F during the year. Daily temperatures average about 80°F. Humidity is steady at 90% in the vault. A dehumidifier keeps humidity fairly constant at 50% to 60% in the recording room, though some seasonal variation might occur.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 25041
SP N-S: 24940
SP E-W: 24820
LP Z: 748
LP N-S: 756
LP E-W: 758

Should thermal insulation decrease drift, all LP systems could operate at an increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 6 to 8 sec (LP)
1 to 2 sec (SP)

AVERAGE AMPLITUDES: 0.04 µ (SP)
1 µ (LP)

REMARKS: No seasonal amplitude fluctuations have been noted at this station in the past, but it is believed that they will be observed on the new standard equipment. Local earthquakes
SEISMOMETER VAULT LAYOUT
FLOOR PLAN OF RECORDING FACILITIES BUILDING

RECORDING ROOM

CONTROL ROOM

USCGS Photo Dryer

Seismic Unit Control Panel

DRY BENCH

DARK ROOM

WET BENCH

N
SEISMMETER VAULT
are frequently recorded at this station, but other natural seismic disturbances have not been noticed in the past. Mud volcanoes are active to the south, but do not seem to affect the instruments.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 0.8 km
The nearest highway is 0.8 km
The nearest dam is 24 km

REMARKS: This installation is relatively isolated from any man-made noise.

OTHER INSTRUMENTS IN OPERATION:

(1) Willmore vertical seismograph (period 1 sec, Mag. 10000)
(2) Willmore horizontal seismometer with a Tinsley 17-sec galvanometer (operated periodically)
(3) Strain gauges

RESEARCH PROJECTS IN PROGRESS:

(1) Development of selective amplifier for electromagnetic seismograph systems (initial design completed and published)
(2) Development of strain seismograph and strain measuring equipment (nearly complete)
(3) Eastern Caribbean earthquake history (complete)
(4) Analysis of earthquake strain release in eastern Caribbean (just commenced)
(5) Special study of earthquakes of volcanic origin, as these occur (just commenced)
STATION FACILITIES

STATION: Tucson, Arizona

STATION DIRECTOR:
Clyde J. Beers

STATION ABBREVIATION: TUC

MAILING ADDRESS:
Observer-in-Charge
Tucson Magnetic and Seismological Observatory
Route 2, Box 682
Tucson, Arizona

TELEPHONE NUMBER:
AX 8-2281

CABLE ADDRESS:
Same as mailing address

GEOGRAPHIC COORDINATES:
Latitude: 32° 18' 35" N
Longitude: 110° 46' 56" W

ELEVATION:
972 meters

HISTORY OF STATION:
Directors: A. K. Ludy (1925-1935)
J. W. Joyce (1935-1938)
R. F. White (1938-1940)
J. H. Nelson (1940-1949)
J. B. Campbell (1949-1953)
M. Cloven (1953-1955)
R. F. White (1955-1958)
R. L. Viets (1958-1960)
C. J. Beers (1960- )

World Array equipment began operating here on December 17, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station, 27.2 km from Tucson, is on the south flank of the Santa Catalina Mountains.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The nearest structures are houses 1.2 km south. There are no large buildings nearby.

LOCAL GEOLOGY:
See geologic map
STATION AND PIER CONSTRUCTION

PIERS:
The seismometer piers are concrete, 1 foot high, and extend to the metamorphic bedrock 2 feet below the vault floor. The piers are isolated from the floor by a space 2 inches wide and 1/4 inch deep, in which a styrofoam strip of the same dimensions has been placed. Beneath the floor fill dirt has been placed against the sides of the piers.

VAULT TEMPERATURE AND HUMIDITY:
Both the seismometer and the recording vaults are rooms within a room, with insulation between the inner and outer wall. There are no heaters. In the spring there are occasional daily temperature fluctuations of 50°F. It is believed, however, that the vault temperature will remain constant. The average high temperature (86°F) occurs in July, the average low (49°F) in December. In the Tucson area, average humidity is 35% or less, being highest during July and August. Humidity conditions in the new vaults are unknown.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>200,000</td>
</tr>
<tr>
<td>SP N-S</td>
<td>200,000</td>
</tr>
<tr>
<td>SP E-W</td>
<td>200,000</td>
</tr>
<tr>
<td>LP Z</td>
<td>1,500</td>
</tr>
<tr>
<td>LP N-S</td>
<td>1,500</td>
</tr>
<tr>
<td>LP E-W</td>
<td>1,500</td>
</tr>
</tbody>
</table>

None of the systems could operate at increased magnification.

BACKGROUND AND NOISE:

- PERIODS OF PREDOMINANT MICROSEISMS: Not given
- AVERAGE AMPLITUDES: Not given
- REMARKS: Microseismic activity at this station has not been studied.
SEISMOMETER VAULT LAYOUT
Cable Buried in 2" Plastic Pipe

Recording Vault

Orientation of Vaults

N

Seismometer Vault
RECORDING VAULT LAYOUT
Recording Room
MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 28.8 km
The nearest highway is 3.2 km
The nearest dam is 2.6 km
The nearest river is 2.4 km (Sabine Creek)

REMARKS: A rock crusher is located about 11.2 km SW of the station. In addition, large blasts occasionally are employed in open pit copper mining nearby. An intermittent stream, approximately 1000 feet east of the station, has a steep gradient, and during heavy rains, which are infrequent, this will be a source of noise.

OTHER INSTRUMENTS IN OPERATION:

(a) N-S, 10-sec period, Wood-Anderson Seismograph
(b) E-W, 10-sec period, Wood-Anderson Seismograph
(c) Vertical, Benioff Variable Reluctance, seismometer with 1/2-sec and 60-sec galvanometer take-offs
(d) Normal magnetograph with modified la Cour D, H and Z variometers of high sensitivity and a clock-driven recorder operated at 20 mm/hour
(e) Rapid-run magnetograph with D, H and Z Ruska Variometers of high sensitivity and one synchronous motor-driven recorder with three drums

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Umeå, Sweden

STATION DIRECTOR:
Dr. Markus Båth

STATION ABBREVIATION: UME

MAILING ADDRESS:
Seismological Institute
University
Uppsala, Sweden

TELEPHONE NUMBER:
018/30258

CABLE ADDRESS:
Not given

GEOGRAPHIC COORDINATES:
Latitude: 63° 49' N
Longitude: 20° 14.6' E

ELEVATION:
15 meters

HISTORY OF STATION:

The first installation at this location was completed on January 25, 1962. Later a new vault for the seismometers was constructed 200 meters to the south. Recorders and console remain at the original site.

World Array equipment began operating at the new vault on August 20, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:

Land around the station is flat. From the site the Umeå River is 1 km, the city of Umeå is 2 km, an airport is 3 km, and a main road is 300 meters. The community of Teg is 1 km from the station.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:

The station is in a wooded area with the nearest buildings (residential) 100 meters away. A 100-foot tower (recording room) is 200 meters north. A power plant is 12 km NE. Apartment buildings are being constructed 150 meters NE of the vault.

LOCAL GEOLOGY:

Bedrock at the site is mainly mica gneiss in contact with pegmatite.
STATION AND PIER CONSTRUCTION

PIERS:

The recorders and the console are in an abandoned water tower with two insulated rooms. Galvanometers are on marble shelves attached to the walls of the tower and recorders are on wooden tables bolted to the floor. The seismometer vault is 200 meters south of the tower. The floor, roof, and walls are made of concrete 18 cm thick, with 10 cm of cork insulation. The instruments are in an inner room constructed of gypseum. There is an air space of 50 cm between the instruments and the outer wall. Electric heaters have been placed in this space and in the floor. The pier extends one meter into the bedrock, and asphalt has been used as the abutting material between the floor and pier.

VAULT TEMPERATURE AND HUMIDITY:

The console and recording rooms have 1000-watt electrical heaters, keeping temperature in these two rooms constant at 20°C. The seismometer vault has electrical heating in the floor and between the inner and outer walls, so that temperature can be closely controlled. Outside temperature will vary from -30°C in winter to 25°C in summer, but vault temperature should not vary more than 5°C. Humidity is very low. It will be highest during July and August.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 50000
SP N-S: 50000
SP E-W: 50000
LP Z: 1500
LP N-S: 1500
LP E-W: 1500

None of the systems could operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 5 to 8 sec

AVERAGE AMPLITUDES: Not given

REMARKS: There are seasonal amplitude fluctuations. Microseismic activity is greatest from December to February and least from June to September. The only other natural seismic disturbances in this area are strong winds in the winter.
LOCATION AND ELEVATION MAP OF UMES, SWEDEN AREA
Recording and Console Building
MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:
The nearest railroad is 3 km
The nearest highway is 300 meters
The nearest dam is 12 km
The nearest river is 1 km

OTHER INSTRUMENTS IN OPERATION:
None

RESEARCH PROJECTS IN PROGRESS:
None
STATION FACILITIES

STATION: Valentia, Ireland

STATION DIRECTOR:
John McWilliams

STATION ABBREVIATION: VLN

MAILING ADDRESS:
Valentia Observatory
Cahirciveen
Co. Kerry, Ireland

TELEPHONE NUMBER:
Cahirciveen 27

CABLE ADDRESS:
Dublin Telex 192

GEOGRAPHIC COORDINATES:
Latitude: 51° 56' N
Longitude: 10° 15' W

ELEVATION:
13.5 meters

HISTORY OF STATION:
Valentia Meteorological Observatory dates from 1860; geophysical observations began in 1888. World Array equipment began operating here October 23, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
See topographic map

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located on the grounds of the Meteorological Service Observatory, 1.2 km from Cahirciveen, a town of 2000 people.

LOCAL GEOLOGY:
The station and observatory buildings rest on slate deposits from the recently uplifted shoreline of the ocean.

STATION AND PIER CONSTRUCTION

PIERS:
All piers are of concrete, attached directly to the underlying rock structure, and isolated from the floor.
TOPOGRAPHIC MAP OF VALENTIA AREA
(elevations in feet)

VAULT TEMPERATURE AND HUMIDITY:
Vault temperature ranges from 60°F to 62°F. Thermostatically controlled electric heating devices are mounted around the interior walls of the seismometer and recording rooms, though heating units in the LP seismometer room have been turned off. Temperature at this location varies 20°F from summer to winter, and daily temperature variations are small. Humidity is no problem, causing only slight defocusing of seismogram traces in the recording area.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>12500</td>
</tr>
<tr>
<td>SP N-S</td>
<td>12500</td>
</tr>
<tr>
<td>SP E-W</td>
<td>12500</td>
</tr>
<tr>
<td>LP Z</td>
<td>750</td>
</tr>
<tr>
<td>LP N-S</td>
<td>750</td>
</tr>
<tr>
<td>LP E-W</td>
<td>750</td>
</tr>
</tbody>
</table>

Under proper weather conditions, all SP systems could operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 6 sec

AVERAGE AMPLITUDES: Vary with the weather
VALENTIA OBSERVATORY, DIP SECTION THROUGH STATION.
REMARKS: Adequate data concerning microseisms is not yet available. Other natural seismic disturbances result from wave action along the Atlantic coast and gale winds.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 64 km
The nearest highway is 0.8 km
The nearest dam is 160 km
The nearest river is 0.4 km

REMARKS: A quarry is 12.8 km from the station. Auto traffic on the nearby highway is not heavy.

OTHER INSTRUMENTS IN OPERATION:

There are meteorological, magnetic, and radiation instruments here.

RESEARCH PROJECTS IN PROGRESS:

None
STATION FACILITIES

STATION: Wellington, New Zealand

STATION DIRECTOR:
Dr. F. F. Evison

STATION ABBREVIATION: WEL

MAILING ADDRESS:
Seismological Observatory
Box 8005
Wellington, New Zealand

TELEPHONE NUMBER:
Wellington 48-650

CABLE ADDRESS:
Not given

GEOGRAPHIC COORDINATES:
Latitude: 41° 17' 1" S
Longitude: 174° 46' E

ELEVATION:
120.3 meters

HISTORY OF STATION:
In 1915 seismograph recording began here under the direction of Dr. C. E. Adams. Mr. R. C. Hayes became director of the station in 1936, and Dr. F. F. Evison became superintendent in 1960. World Array equipment began operating here May 17, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is in the suburb of Kelburn, 1.6 km from the center of Wellington. The Rimutake mountains are 24 km distant and the mouth of the Hutt River is about 16 km away.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is located in a residential district. Botanical gardens surround the site. The two-story meteorological building is about 75 yards distant and at an elevation 7.5 meters lower than the station.

LOCAL GEOLOGY:
The station is on Mesozoic greywacke which forms the basement throughout Wellington Province.
STATION AND PIER CONSTRUCTION

PIERS:

The vaults are below ground level in the observatory basement. Observatory walls are from 1 1/2 feet to 2 feet thick. The piers and the floor are made of concrete and are not isolated from each other. Piers extend one foot above the floor. The vault floor sits directly on a massive greywacke basement rock, and it is possible that there is some till or rubble between the floor and the bedrock.

VAULT TEMPERATURE AND HUMIDITY:

No environmental control is present. Daily temperature fluctuations are not expected in the seismomter vault, though temperature may vary one or two degrees per week. Seasonal temperature fluctuation should be less than five degrees. The installation is below ground level and during heavy rains some water may enter the instrument rooms. Humidity in the recording rooms and in the darkroom is usually very high.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z</td>
<td>6250</td>
</tr>
<tr>
<td>SP N-S</td>
<td>6250</td>
</tr>
<tr>
<td>SP E-W</td>
<td>6250</td>
</tr>
<tr>
<td>LP Z</td>
<td>750</td>
</tr>
<tr>
<td>LP N-S</td>
<td>750</td>
</tr>
<tr>
<td>LP E-W</td>
<td>750</td>
</tr>
</tbody>
</table>

No possible increased magnification for these systems has been reported.

BACKGROUND AND NOISE:

Not given

MAN-MADE NOISE:

Not given

OTHER INSTRUMENTS IN OPERATION:

1. One Willmore Z ($T_o = 1.0$ sec, $T_g = .25$ sec, Mag. = 7000)
2. Two Wood-Anderson horizontals (Period = .8 sec, Mag. = 7800)
3. One three-component, strong-motion Imamura Seismograph

RESEARCH PROJECTS IN PROGRESS:

Not given
WELLINGTON INSTRUMENT ROOMS
STATION FACILITIES

STATION: Weston, Massachusetts
STATION ABBREVIATION: WES

STATION DIRECTOR:
Daniel Linehan, S. J.

MAILING ADDRESS:
Weston Observatory
Weston 93, Massachusetts

TELEPHONE NUMBER:
Twinbrook 9-0950

CABLE ADDRESS:
WESOBBC

GEOGRAPHIC COORDINATES:
Latitude: 42° 23' 4.9" N
Longitude: 71° 19' 19.5" W

ELEVATION:
60 meters

HISTORY OF STATION:
World Array equipment began operating here on November 22, 1961.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The land surface is relatively flat and has glacial features. Boston is 19.2 km away, Waltham 6.4 km away, and the Charles River 3.2 km away.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
The station is in the country on property owned by Weston College. The nearest building is 800 feet away.

LOCAL GEOLOGY:
The bedrock at this location consists of Paleozoic metavolcanics. There is a cover of glacial debris varying from 0 to 200 feet. At the station, the cover is 8 feet.

STATION AND PIER CONSTRUCTION

PIERS:
The vault building consists of four rooms and is enclosed by another building. The piers are made of concrete, attached to the bedrock 8 to 10 feet below ground level, and isolated from the vault floor. Cables pass from room to room through conduits.
SEISMOLOGICAL FACILITIES, WESTON OBSERVATORY
VAULT TEMPERATURE AND HUMIDITY:

Temperature control is excellent, with no more variation than a few degrees Fahrenheit throughout the building. The instrument rooms have steel and asbestos walls and an insulated ceiling. Conductance heating is present in the seismometer rooms and a dehumidifier is used in the galvanometer room. Room temperatures are controlled by the amount of heat in the whole building, usually about 74°F. Seasonal temperature fluctuations will be no more than a few degrees Fahrenheit, in spring and autumn. Humidity in the instrument rooms is generally low, with highest humidity in August and early September.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

SP Z: 50000
SP N-S: 50000
SP E-W: 50000
LP Z: 1500
LP N-S: 1500
LP E-W: 1500

The SP systems can operate at increased magnification when microseismic activity is low.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 2 to 8 sec and 90 to 120 sec

AVERAGE AMPLITUDES: 6000 µ

REMARKS: Microseisms are greatest in January, least in July. The major microseismic activity is associated with winter storms at sea. Tropical cyclones during the hurricane season are recorded when the storm center is over deep water. Minor activity is evident during the approach of meteorological fronts. There are an average of 50 local earthquakes per year.

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 2.4 km
The nearest highway is 3.2 km (a country road is 500 ft away)
The nearest dam is 128 km
The nearest river is 3.2 km

REMARKS: A quarry is 3.2 from the site, but blasting does not disturb station instrumentation. Railroad trains are recorded but do not interfere with earthquake recording.
OTHER INSTRUMENTS IN OPERATION:

(1) Benioff three-component 100 kg seismograph system (period = 1 sec)
(2) Microbarographs
(3) Rubidium vapor magnetometers
(4) High and low sensitivity variometers

RESEARCH PROJECTS IN PROGRESS:

(1) Staff research in local earthquakes by attempting to erect a network of SP stations in New England
(2) Revision of New England Travel Times from blasts and local quakes
(3) Seismic survey studies of glacial deposits and cover materials in New England
(4) Comparison of seismic and terrestrial magnetic phenomena
(5) Development of visible recording systems
STATION FACILITIES

STATION: Windhoek, South Africa
STATION DIRECTOR:
Dr. F.C. Truter

STATION ABBREVIATION: WIN
MAILING ADDRESS:
Geological Survey
P. O. Box 401
Pretoria, Rep. of South Africa

TELEPHONE NUMBER:
2435, Windhoek

CABLE ADDRESS:
Met, Windhoek

GEOGRAPHIC COORDINATES:
Latitude: 22° 34' S
Longitude: 17° 6' E

ELEVATION:
1700.7 meters

HISTORY OF STATION:
Operations began in 1959 with the installation of a Wilson-Lamison SP Z seismometer at
the weather station. World Array equipment began operating here November 28, 1962.

STATION ENVIRONMENT

LOCAL GEOGRAPHY:
The station is on a small hill 1.6 km SE of the center of the city of Windhoek. The city is
in a valley surrounded by small hills. Three nearby rivers are usually dry.

STATION'S RELATION TO OTHER BUILDINGS OR MAN-MADE STRUCTURES:
Windhoek High School is 250 meters to the west and 20 meters lower than the station in
elevation. Adjoining the station property is a dormitory for high school students. The adminis-
trative offices of the SW Africa government are 600 meters north.

LOCAL GEOLOGY:
The station rests on a large mica schist outcrop which is approximately 2000 meters
thick. The average dip of the strata is 23° and the strike is ENE. The strata forms the
Proterozoic Damara System. There are some north-south faults east and west of the station.
VAULT LOCATION MAP FOR WINDHOECK, SW AFRICA
STATION AND PIER CONSTRUCTION

PIERS:

The seismometer and galvanometer piers are constructed of concrete, isolated from the vault floor, and anchored to the mica schist approximately 2 meters below floor level. Recorder piers are made of bricks built up from the floor and have a smooth cement top.

VAULT TEMPERATURE AND HUMIDITY:

There is no environmental control present. An average temperature fluctuation of only 2°C is expected in the instrument rooms. Humidity is no problem at this station. Average humidity is 34%, with low readings (19%) in September, high (51%) in February.

STATION INSTRUMENTATION

MAGNIFICATION OF COMPONENTS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Magnification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Z:</td>
<td>100000</td>
</tr>
<tr>
<td>SP N-S:</td>
<td>100000</td>
</tr>
<tr>
<td>SP E-W:</td>
<td>100000</td>
</tr>
<tr>
<td>LP Z:</td>
<td>3000</td>
</tr>
<tr>
<td>LP N-S:</td>
<td>3000</td>
</tr>
<tr>
<td>LP E-W:</td>
<td>3000</td>
</tr>
</tbody>
</table>

None of the systems can operate at increased magnification.

BACKGROUND AND NOISE:

PERIODS OF PREDOMINANT MICROSEISMS: 1 and 6 sec

AVERAGE AMPLITUDES: 0 to .06 μ

MAN-MADE NOISE:

FROM THE SEISMOMETER VAULT:

The nearest railroad is 3.2 km
The nearest highway is 0.8 km
The nearest dam is 9.6 km
There are no significant rivers in the area

OTHER INSTRUMENTS IN OPERATION:

Not given

RESEARCH PROJECTS IN PROGRESS:

None
DISTRIBUTION LIST

U. S. Coast & Geodetic Survey, Geophysics Division
Washington 25, D. C.
ATTN: Mr. L. Murphy 300

Air Force Office of Scientific Research, Geophysics Division
Washington 25, D. C.
ATTN: Lt. Col. Best 2

Headquarters, USAF (AFTAC TD-1)
Washington 25, D. C.
ATTN: Lt. Col. Ridenour 2

Nuclear Test Detection Office
Advanced Research Projects Agency
Washington 25, D. C.
ATTN: Dr. C. Bates 2

AFCRL, Headquarters
Laurence G. Hanscom Field, Bedford, Massachusetts
ATTN: Major Gray 2

U. S. Geological Survey, Branch of Crustal Studies
7580 W. Sixteenth Street
Lakewood 15, Colorado
ATTN: Mr. L. Pakiser 2

Defense Documentation Center
Cameron Station
Alexandria, Virginia 10