PERU SEISMIC NETWORK

BEST AVAILABLE

FINAL REPORT

AID-CIW-IGP Seismology project for Peru.

Executive Summary

The primary object of this project was to provide timely, high quality seismological information to the relevant authorities so that informed decisions could be made about hazard assessment and mitigation. The technology and training supplied is that which has been deemed to be most promising in other regions with a large earthquake threat. For example, both Japan and California employ high resolution seismic networks in conjunction with sensitive strain monitoring arrays to help evaluate the state of stress in their earthquake-prone regions. This equipment is expensive and therefore implementation of functioning networks required a substantial infusion of outside funds.

It is not the function of AID-CIW to provide long term operating funds for such networks nor is it AID policy. In order for this project to be considered a success the Peruvian government had to establish a stable funding base. It is gratifying that this has developed from the earliest days. For this project, the IGP built an earthquake-proof building to house the computer and data processing equipment, surrounded by offices and workshop facilities. The funds dedicated specifically to the operation of the AID-CIW-IGP network increased from $16,000 in 1985 to $121,000 for 1988. An additional $82,000 has been made available in the current fiscal year for further equipment purchases. It should be realized that this substantial funding is being provided by the Peruvian government even though the Peruvian economy is in a very bad state at the moment. The total support by Peru, including salaries, for the six years 1982 – 1987 is $2,154,938 (see Appendix 3, pages 118–119). This appendix also indicates the large number of personnel; seismologists, analysts, and technicians who are involved in the project.

The improvement in the operation of the real time earthquake locating system is documented in pages 124 – 126. In July 1983 only about 25 events were detected every month. By December 1986 nearly 100 events were located every month. The system

downtime similarly improved from an average of more than 10% to a few percent over the same period.

One of the important goals of the real time system is to notify the civil defense authorities if a damaging earthquake occurs and to indicate its exact location. Before this system was installed it often took days before help could be sent to a severely damaged village because the location of the earthquake was not known and communications were down. Once the system became fully operative, it has been demonstrated that the Civil Defense authorities are notified of the location and magnitude of a potentially damaging earthquake within thirty minutes of its occurrence. The normal duties of the Seismic Alert personnel are described in pages 16–24. In addition, the monthly bulletins (see pages 97–114) alert the authorities to any changes in the seismicity which may indicate increasing hazard. The data and analysis listings are supplemented by maps (page 108). If there seems to be unusual activity, this may be high-lighted in a large scale map such as shown in page 114 to draw the attention of the authorities (e.g. civil defense) to the area. In the future, this will be supplemented by the observations of the strain changes.

The maps on pages 88, 89, and 90 show the location of the seismic stations and the strainmeters, respectively. We emphasize that despite the complications of increased terrorist activity, **all** instrumentation described in the original proposal has been installed and is functioning.

There remain two major problem areas. The number of personnel trained to the required level to efficiently operate the sophisticated equipment and to interpret and analyze the data is the barest minimum. Dr. Ocola has a University of Wisconsin Ph.D degree and is a first class scientist. More of the promising young scientists should be trained to the same level. Edmundo Norabuena has attended computer courses in Massachussets (see pages 128, 129) but one should not have to rely on only one expert. Norabuena should also be given schooling in seismology to make him even more effective in the program.

The number of replacement components is marginal. Currency restrictions make purchase of non-national (e.g. US made) equipment very time consuming. Unexpected

damage by lightning, the desireability of only short visits to areas with a terrorism hazard, requires a good stock of parts. Therefore more telemetry equipment is required in order to have the strain signals available in Lima in real time.

The highly capable functioning analysis system with its support personnel provides an opportunity for further hazard mitigation in Peru with minimal expense. The threat posed by renewed activity at volcano Misti near Arequipa could be monitored if telemetry equipment and seismometers were supplied. A network around the Chirapiura dam in the north is telemetered to Lima and the seismic activity is monitored there. The telemetered stations are shown on map page 89.

All the relevant material purchased under this AID grant (pages 12, 81–83, 92, 130, 131) has now been transferred to the IGP in Lima, and the operation has become essentially a purely Peruvian enterprise.

Yours sincerely,

I. Selwyn Sacks

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Principal Investigator

AID-CIW-IGP seismology project

Final Report of the Project:

AID-CIW/IGP SEISMIC NETWORK

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Part – I

Execution, Implementation, and Investigation

Science Department for
SOLID EARTH PHYSICS:

APPLIED GEOPHYSICS

SUMMARY

This current document summarizes the actions executed under the AID-CIW/IGP SEISMIC NETWORK Project subject to the "Technical Cooperation Agreement in Seismology", signed by CIW and IGP in order to further the knowledge of seismicity and processes which give rise to the earthquakes in the country.

Upon concluding the Project, the principal objectives have been reached, namely:

1. A Center for the Real-Time Processing of Seismic Signals has been established.
2. An Automatic System for Seismic Alert in Real-Time has been partially established.
3. A Radio-Telemetry Seismic Network has been established.
4. A seven-station Dilatometer Network has been established.
5. The implementation of a Geophysics Information System has been initiated.

The execution and implementation of the Project is in the care of *la Dirección de Física de la Tierra Sólida: Geofísica Aplicada* (The Solid Earth Physics Department: Applied Geophysics). In its initial stages it was in the care of *la Dirección de Sismología* (The Seismology Department) under the direction of Dr. Daniel Huaco. The operation and maintenance of the stations in the Project's networks have been under the direction of *la Dirección de Servicios Técnicos* (the Technical Services Department).

The magnitude of IGP's effort can be judged by the number of scientific staff, professional and technical, who have participated (64), and the funds which were put at the disposal of the Project; the following is a summary:

1. Execution and implementation:

A. 14-people (wages and remunerations)	US$	73,296
B. Funds for implementation		106,000

2. Operation and maintenance

A. 50-people (wages and remunerations)		1,471,950
B. Operation and maintenance		682,988

The total cost is ..... US$ 2,334,234

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1. INTRODUCTION

The prerequisites for following the evolution of seismic activity in the Lima area, as highlighted by Dr. B. Brady's prediction of catastrophic earthquakes, points out the precarious situation of the Instituto Geofísico del Perú (IGP), as to warrant:

i) access to technical information which is trustworthy and of good quality immediately after a seismic event has occurred.

ii) prompt diffusion of information to el Systema National de Defensa Civil (the National System of Civil Defense) for the taking of immediate preventive measures.

iii) a Geophysics Data Base which would permit the rapid verification of the occurrence of predicted premonitory events, and permit one to compare them with the seismic activity of severe earthquakes having occurred formerly in the same area.

Faced with this situation, and after having established permanent contact between AID-Washington (USA) authorities, Dr. B. Brady, and IGP, with the support from U.S. Geological Survey (USGS) in the beginning and later with the participation of the Carnegie Institution of Washington (CIW), the idea arose of implementing a data acquisition system which would resolve, at least in part, the 3 prerequisites mentioned in the lines above.

The AID-CIW/IGP SEISMIC NETWORK PROJECT is a joint effort between CIW and IGP, with financial support from AID and IGP (Investment Project 101010: AID-CIW/IGP NETWORK) for which a "Technical Cooperation Agreement in Seismology" was signed between CIW and IGP. The Principal Investigator of the Project, on the part of IGP, since its beginning until June 1986, was Dr. Daniel Huaco in the area of Seismology. The administration of the Project passed to la Dirección Científica de Física de la Tierra Sólida: Geofísica Aplicada (the Science Department for Solid Earth Physics: Applied Geophysics) since September 1986.

In accordance with the organic structuring of IGP, la Dirección de Servicios Técnicos (Technical Services Department) — formerly Oficina de Servicios Técnicos — is responsible for:

1. the installation of the Project's seismic stations.

2. the operation and maintenance of the Project's seismic stations and dilatometers.

3. the analysis and dissemination of seismic information.

The final report of this unit's participation is presented in Part II.

On the other hand, the processing of information from the dilatometers, as well as special investigations concerning specific problems is the responsibility of the Applied Geophysics Staff.

In the current report the principal successes gained from the Project are summarized.

2. Objectives

The AID-CIW/IGP NETWORK PROJECT objectives are:

i.) to establish a Center for Processing Seismic Signals in Real-Time,

ii.) to implement an Automatic System for Seismic Alert in Real-Time,

iii.) to implement a Geophysics Information System for the seismic prognosis of the national territory,

iv) to set up a Radio-Telemetry Seismic Network, and

v) to set up a Network of dilatometers (Volume strainmeters),

with the purpose of furthering the knowledge of seismicity and processes which give rise to the earthquakes and the tectonics of the central region of Perú, and furnishing information in real-time to el Systema Nacional de Defensa Civil (the National System of Civil Defense) for the taking of preventive measures in the event of strong earthquakes.

3. CENTER FOR AUTOMATIC PROCESSING OF SEISMIC SIGNALS IN REAL-TIME

The purpose of this Center is to answer the needs of digital computation and information, in order to:

1. Implement the Geophysics Data Base which allows one to conduct studies aimed at seismic prediction.

2. Give support to the services dedicated to the distribution of seismic information, in response to requests of national or foreign users.

3. Support scientific research and services which IGP renders in its area of competency, in particular:

   - "To investigate the environment and to study the procedures which allow one to forsee and reduce the destructive impact of disasters which are natural or induced by man" (Art. - 5to. d, Ley Orgánica IGP, D.L. 136).

   - "To establish and maintain a Geophysics Data Bank with results and data from the works or study or exploration projects which cease being strategic for the public or private sector which is producing them" (Art. 5to. m, Ley Orgánica IGP, D.L. 136).

The core part of the Center consists of computers and peripherals acquired with funds from AID through DTM-CIW, and those things which were acquired with national funds.

IGP has contributed with the following equipment:

1. Smart terminals:

   - 3 micros Multitech ACCEL 900H with their printers and 40- and 80-megabyte hard disks

   - 3 Heathkit H-90-A micros

   - 1 digital-satellite clock, Kinemetrics.

2. An AMLC 5154F Controller for the 2655 PRIME computer. The computer was acquired without a controller. This addition will allow one to connect 16 additional terminals to the 8 existing ones.

3. A 300 megabyte PRIME disk. It is the only one which presently functions. The disk that came with the PRIME 250 computer does not function.

With the funds from AID the following equipment was acquired for the Computer Center:

- 1 PRIME printer
- 1 Tektronix graphics terminal
- 2 PT-25 PRIME terminals
- 1 digital printer
- cabinet for tapes
- 2 recorders for magnetic tape
- 1 64-megabyte disk unit
- PRIME 250 computer
- 490-megabyte disk unit (new)
- PRIME 2655 computer (new)
- 1 playback unit, Kinemetrics.

The Center is administered by a Dirección de Informática (an Information Department), where three people and a director work. This department is charged with the preventive maintenance of IGP equipment: peripherals, microcomputers, terminals, and it coordinates the maintenance of equipment acquired from PRIME, USA, with funds from AID.

The computer systems of the Center are compatible with the IGP Computer Center at the Radio Observatorio de Jicamarca (ROJ), while overflowing with efficient support for scientific research.

The Center is the principal tool of IGP's Servicio Sismológico (Seismological Service). Its

functions and duties are described in Appendix A. The Center also lends support to la Dirección Científica de Física de la Tierra Sólida (the Science Department for Solid Earth Physics) where the following projects are currently being conducted: "Development of Methods for Seismic Prediction", under the direction of Tech. Ernesto Deza, "Geologic and Volcanic Hazard", under Dr. David Huamán, and "Seismic Microzonification", "Seismic Hazard and Regional Geodynamics", "Gravimetry", and "Terrestrial Magnetism", under direction of Dr. Leonidas Ocola.

The Center also lends support to the Science Department for Remote Sensing and Atmospheric Phenomena, whose principal project is the "Study of the El Niño Phenomenon", under the direction of Dr. Pablo Lagos, and "Numerical Simulation of Tsunamis along the Peruvian Coast", under Dr. Carlos Carbonel.

An important support which the Center gives is the interconnection of peripherals which permit the reading of cassette tapes from the seismic event recorders directly into the PRIME computer. IGP currently has seven DR100's from Sprengnether and six PDR1's from Kinemetrics. These units are particularly useful for the studies of seismic aftershocks following a severe seismic event and for the study of local seismicity.

The Center also offers services to IGP's Central Administration in accounting and personnel matters.

With the budget of the 1987 fiscal year, 2 digitizers with tablets of high resolution and precision will be acquired. One of them will be dedicated to the reading of analog seismograms and the other will support the jobs and projects concerning earth sciences and engineering seismology. This latter digitizer will be used, in addition, for the digitization of the records from the Project's 7 dilatometers.

For the year of 1988, the acquisition of a digital flatbed plotter which permits one to make maps has been tentatively approved. Also, the acquisition of more smart terminals has been put on the agenda.

4. AUTOMATIC SYSTEM FOR SEISMIC ALERT

The Automatic System for Seismic Alert consists of the Radio Telemetry Seismic Network and the software "Autoseis" acquired with funds from AID for the detection of seismic events in real-time.

The system is monitored permanently by an on-duty operator who not only watches over the functioning of the Computer Center, but also reprocesses and verifies the "correct" location of felt seismic events in the national territory and/or those with magnitudes of

4.2 m_b or greater (Appendix A).

Due to the geometry of the seismic "array" of the Radio Telemetry Seismic Network, and to the reduced number of seismic stations which contribute seismic information in real-time, the system continually is "assisted" by the operator, who complements the information derived through the controls of the "Autoseis" with information from semi-portable or teleseismic stations which are not connected to the Radio Telemetry Network.

The information which is produced is immediately reported to the Defensa Civil (the Civil Defense) and to the government authorities. This is the information which the Defensa Civil (the Civil Defense) uses to activate or not activate its emergency aid system.

In addition, el Servicio Sismológico (the Seismological Service) counts on the telephone exclusively for immediate communication with el Servicio de Hidrografía y Navigación de la Marina (the Marine Hydrography and Navigation Service) for responding to tsunami messages. IGP operates the "Maremoto (seaquake)" station, integrated with the "Sistema de Alerta Contra Tsunamis" (Alert System Against Tsunamis) with its center in Honolulu, Hawaii, USA.

The information which this "Automatic System for Seismic Alert" produces takes shape in the Preliminary Seismic Bulletins which IGP publishes and distributes locally.

The system is 90% implemented and functions efficiently. Improving the area of archiving and processing of seismic information is expected to happen in the next fiscal year.

5. GEOPHYSICS INFORMATION

IGP, in the area of research and studies, has set up seismic catalogues, Data Bases in gravimetry, magnetism, geophysics and seismology engineering. In order to make it efficient, the formal development of procedures for information management, administration, and distribution is required. This is an area of recent creation and it is expected to be developed in the following years.

6. RADIO TELEMETRY SEISMIC NETWORK

The Radio Telemetry Seismic Network consists of instrumentation stations with equipment acquired with funds from AID (7 stations) and of IGP's own stations and of those stations from agreements with other national institutions.

IGP has made great efforts to install and keep operative the Radio Telemetry Seismic Network which is set up in the central part of Perú. The network is made up of the following Stations: (Fig. 1):

Station	Lat.(S)	Long.(W)	Elev.(m)
1. Ancona	10.851	75.957	4800
2. Chiclayo	06.765	79.865	0060
3. Guadalupe	13.992	75.783	0550
4. Juni	11.549	75.754	4480
5. Morro Solar	12.181	77.031	0278
6. Pajonal	10.639	75.288	2800
7. Paracas	13.829	76.331	0220
8. Quilmaná	12.943	76.437	0510
9. Pta. Salinas	11.236	77.611	0282
10. Sante Fe	11.677	76.193	5200
11. Suche	11.960	76.549	2880

The seismic stations of Chiclayo and Eten in the northern part of the country have been integrated through transmission of seismic signals via microwaves.

On the other hand, instrument sheds have been constructed at the stations in Cosmos and Pajonal. However, due to the social situation of the country in the last years, it is very risky to go to the installation.

In addition to the normal radio telemetry seismic stations, during the current fiscal year, one expects to install five mobile elements of a portable radio telemetry seismic network of short range in the Lima Metropolitan area.

For the next year, el Ministerio de Economía y Finanzas (the Ministry of Economics and Finances) approved, at first request, funds for three complete radio telemetry systems. These systems will be installed in the Ica area, to the south of the current Radio Telemetry Seismic Network, if the seismic activity continues to be intense in this zone, if not, they will be installed in southern part of Perú and they will be interconnected to the

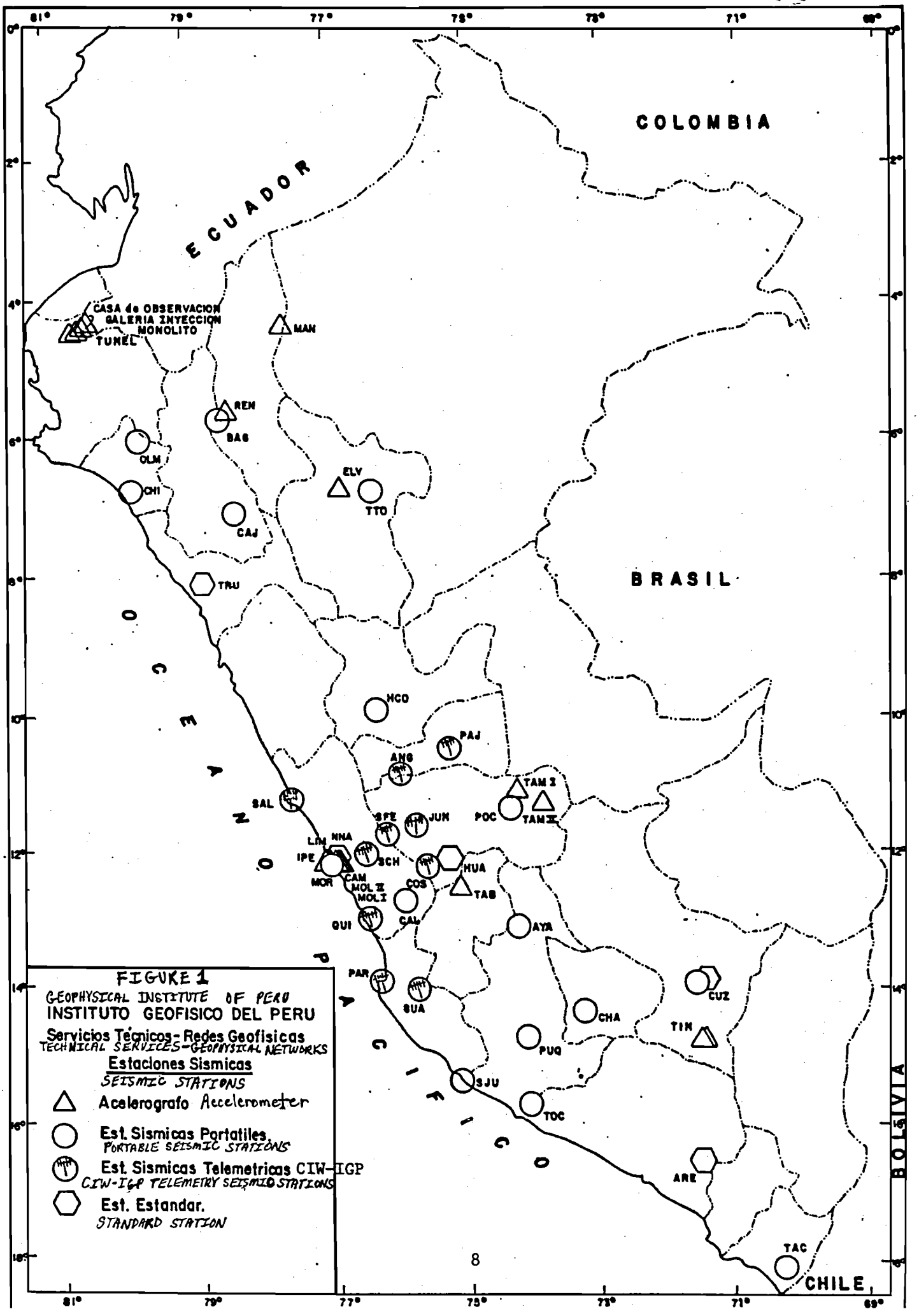

FIGURE 1

GEOPHYSICAL INSTITUTE OF PERU

INSTITUTO GEOFISICO DEL PERU

Servicios Técnicos - Redes Geofisicas

TECHNICAL SERVICES - GEOPHYSICAL NETWORKS

Estaciones Sismicas

SEISMIC STATIONS

△ Acelerografo Accelerometer

○ Est. Sismicas Portatiles

PORTABLE SEISMIC STATIONS

Est. Sismicas Telemetricas CIW-IGP

CIW-IGP TELEMETRY SEISMIC STATIONS

⬡ Est. Estandar.

STANDARD STATION

"Center for the Automatic Processing of Seismic Signals" via microwaves.

7. DILATOMETER NETWORK

During the period from September 1986 to March 1987 the drilling of the holes for the housing of the dilatometers supplied through AID was completed. The dilatometers were installed by CIW in February-March 1987. The dilatometer network is shown in Fig. 2. The whole apparatus was acquired with funds from AID. The technical reports concerning the drilling of the holes at Lachay, Songos and Pampa-Blanca is presented in Appendix B.

The stations which constitute this network are:

Station	Lat.(S)	Long.(W)	Elev.(m)
1. Ñaña	11.987	76.842	0575
2. Quilmaná	12.943	76.437	0510
3. Guadalupe	13.992	75.783	0550
4. Paracas	13.829	76.331	0220
5. Lachay	11.21	77.21	0175
6. Songos	11.52	76.28	1700
7. Pampa-Blanca	13.29	75.28	1600

During the 1987 fiscal year the construction of the instrument sheds at the three last stations will be finished. To date, the instrument shed at Pampa-Blanca needs to be constructed and the one at Songos needs to be finished (it is fully underway).

The stations at Ñaña, Quilmaná, Paracas, and Guadalupe are producing very interesting recordings. A professional physicist has been hired to convert the analog information to digital and to process the information in order to keep the evolution of the deformation in the central region of Perú up to date. For digitization one will use the digitizing table with high precision and resolution which will be acquired this current year.

The stations at Pampa-Blanca, Songos, and Lachay are in a process of stabilization. The installation of the solar cells at these stations has been programmed for the next year.

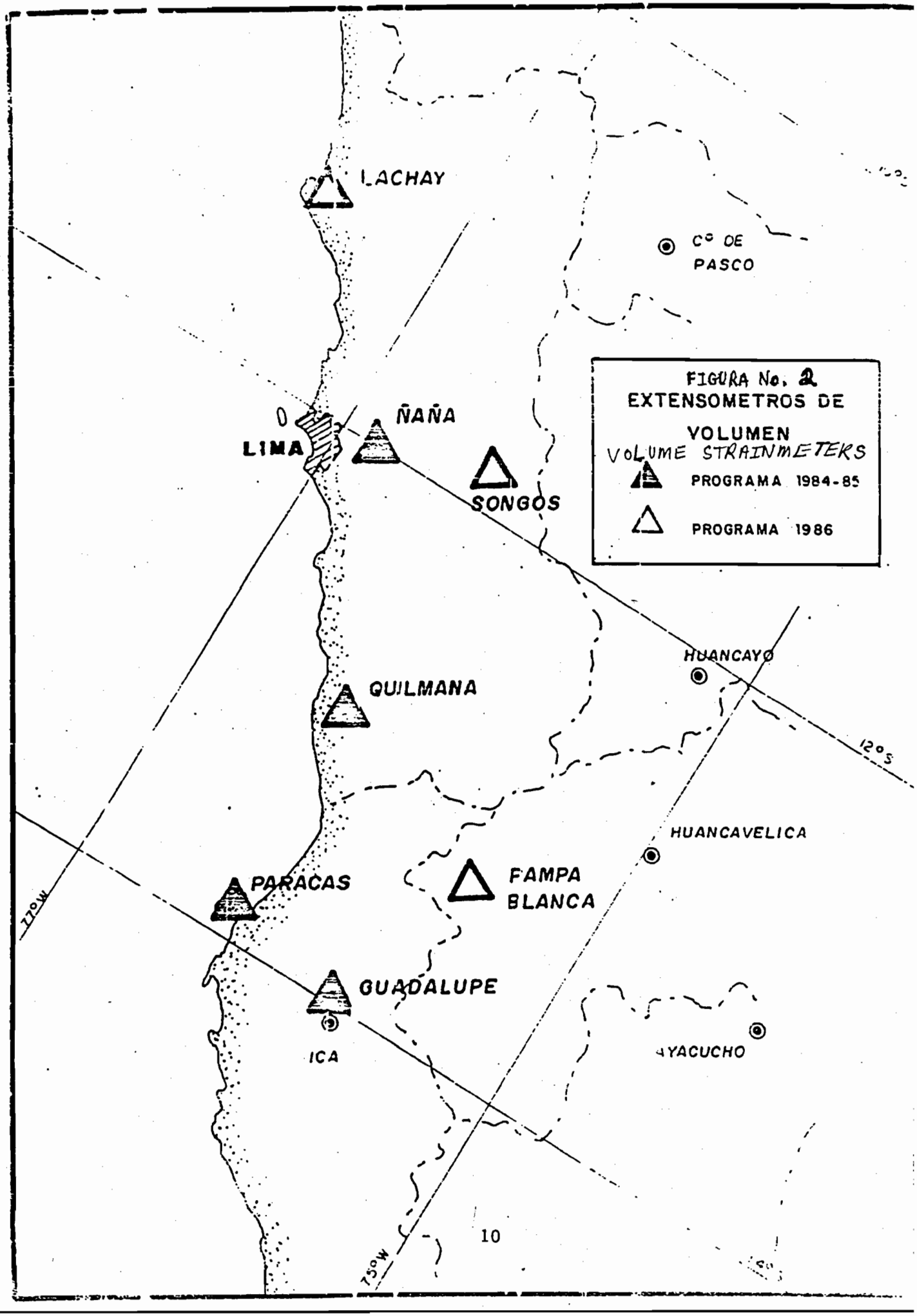

FIGURA No. 2
EXTENSOMETROS DE VOLUMEN
VOLUME STRAINMETERS
PROGRAMA 1984-85
PROGRAMA 1986

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8. PASSIVE SEISMIC EXPERIMENT: CENTRAL-EAST SUB-ANDEAN ZONE

IGP participated using its staff and its own equipment in the passive seismic experiment in the central-east sub-Andean zone of Perú. This experiment was directed by CIW through Dr. J. Schneider, and was carried out during the months from May to August 1985.

IGP participated with a complete brigade of 3-people, vehicle, and 5-semiportable seismic stations. These were operated in the Satipo-Pozuzo zone in the central-zone. The stations which Dr. Schneider brought, 9 from U. of Wisconsin, 5 from AID/CIW, were installed in the central-west jungle: Shepahua-Yurimaguas. One station was being set up very close to the border with Brazil. IGP furnished technical support staff.

The copying of the digital recordings on cassette tapes and the readings of the seismograms were done in Lima.

9. SUMMARY OF ECONOMIC SUPPORT FROM THE PERUVIAN GOVERNMENT: IMPLEMENTATION

A. Personnel

The economic support from the Peruvian Government translates into, not only paying the salaries of scientific and technical staff, and the auxilliary staff dedicated to keeping the Radio Telemetry Seismic Network operative, but to covering the requirements of staff in the execution of the Project, processing, disseminating, and filing of seismic and geophysical information which allows one to further the knowledge of the country's seismicity.

In this regard and parallel to its efforts in the area of geophysics, IGP began a program two years ago directed at the evaluation of geologic and volcanic hazard. Various projects are held with ORSTOM (France), to study: active faults of the Cusco area, dangerous geological and volcanic faults in the Arequipa zone, and distribution and dating of the marine terraces along the Peruvian coast. In addition, 3-local seismicity projects have been executed on the groundwork of the ORSTOM scientific group.

The degree to which the staff at la Dirección Científica de Física de la Tierra Sólida (the Science Department for Solid Earth Physics) participated in the project is detailed in Appendix C. This particular staff has participated in the execution of the Project since 1985 to this date. The wages and remunerations add up to a total of US $1,545,246.

B. Implementation Funds

The funds dedicated specifically for the AID-CIW/IGP SEISMIC NETWORK PROJECT, through the years are as follows:

1985:	US$ 16,000
1986:	US$ 50,000
1987:	US$ 50,000
1988:	US$ 121,600

On the other hand, during the current fiscal year, the Peruvian Government assigned the equivalent of US$ 82,000 additional to the regular operational funds, as part of the operational funds of the Dirección de Servicios Técnicos (Technical Services Department) (Part II, current document), in order to attend to the operating of the Seismic, Extensometer, and Dilatometer Networks.

10. SUPPORT FROM AID

A. Equiping the Project

AID contributed to the Project with:

1. PRIME computers: 250 and 2655.

2. Radio telemetry seismic stations: 7

   - seismometers

   - radio transmitters and receivers

   - signal processors, and

   - antennas

3. Dilatometers: 7 stations.

4. Portable equipment: 5 Kinemetrics PDR1 systems (one of them was vandalized during the Sub-Andean zone seismic experiment), and one play-back unit.

B. Funds: Supplies and Training

AID contributed generously to the acquiring of electronic parts and components, tools and work apparatus, and training of a technician in the managing and administering of the PRIME-Autoseis computer system, and in the training of Dr. Huaco. These contributions were fundamental to the Project's success.

C. Seismic Experiment of the Sub-Andean Zone

AID furnished funds: materials and travel allowance for the acquisition of seismic data via the semiportable systems from the University of Wisconsin, IGP, and those of the Project.

11. CONCLUSIONS AND RECOMMENDATIONS

1. the AID-CIW/IGP SEISMIC NETWORK PROJECT has helped to initiate a new era in studies and research in the area of natural hazards, in particular with regard to seismic hazard.

2. The real-time computing system allows one in a rapid fashion to respond to the need for locating the hypocenters of severe earthquakes for prevention and assistance purposes, and to respond to the requirements of the Defensa Civil (the Civil Defense).

3. The Geophysics Data Base has allowed IGP to accomplish using one of the mandates that it has from the Peruvian Government: the permanent recording of geophysical parameters, with the purpose of conducting studies and research in order to take preventive measures, in addition to answering the requests concerning national user information.

4. The financing on the part of AID and the interest and effort displayed by the Principal Scientific Investigator from AID has served as a catalysis and pressure to make state establishments conscientious and to gain economic support for studies concerning natural hazards.

5. It is recommended that AID continue the economic support for the training of professional and technical staff, and the supplying of electronic parts for the preventive maintenance of computers and peripherals acquired through AID.

6. The response of the Peruvian Government is highly favorable to the development of the AID-CIW/IGP SEISMIC NETWORK PROJECT (Investment Project 101010).

7. A project is being prepared which allows one to monitor the activity of active volcanoes in the southern part of Perú. With this project the installation of a regional office in Arequipa, where one will obtain analog recordings, is being contemplated. At the same time, these signals will be transmitted to Lima to the "Center for Automatic Processing of Seismic Signals in Real-Time", via microwaves. It is recommended that AID lend technical and financial support for the implementation of the Seismic Network and other geophysical sensors in the vicinity of the currently active volcanoes and that the information be integrated with the Central Peruvian Network.

Lima, 05/11/87
LO:ma

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APPENDIX A

MANUAL OF THE EMERGENCY AND SEISMIC ALERT SERVICE

1. Responsibility

IGP since 1981 has been implementing a "Center for the Automatic Processing of Seismic Signals in Real Time" at the IGP Central Laboratory, in order to foresee the necessary media for the response of the Emergency and Seismic Alert Service in Real Time. This service is part of el Servicio Sismológico (the Seismological Service) and is responsible for the following tasks:

i. Locating in Real Time, earthquakes with magnitudes greater than 3.5 mb, felt or unfelt, which occur in the national territory.

ii. Creating Preliminary Seismic Bulletins of located earthquakes.

iii. Transmitting these bulletins to the Civil Defense Authorities, Government Authorities, and media for dissemination in general.

iv. Responding to Tsunami Alerts.

v. Announcing the arrival times of strong regional earthquakes.

vi. Analyzing all the seismograms from the Central Seismic Station, according to the instructions generated from el Servicio Sismológico (the Seismological Service) and to file the seismic information daily.

vii. Locating hypocenters when it is possible, processing them.

viii. Keeping Seismic Bulletins (in ISC Format) up to date.

2. Personnel

The staff of the Emergency and Seismic Alert Service is made up of:

i. An operator responsible for the operation of the Center for Automatic Processing of Seismic Signals in Real Time.

ii. An assistant operator responsible for the Seismic System for Analog Recording of the Central Seismic Station.

iii. A person responsible for keeping the Central Seismic Station's analog recording system operative.

iv. A person responsible for keeping the Central Laboratory's Computer System operative.

The first three people depend directly on la Dirección de Servicios Técnicos (the Technical Services Department). La Dirección de Informática (the Information Department) will designate the fourth person.

3. The Objective of the Manual

The objective of the current manual is to briefly describe the principal tasks which each one of the members, responsible for the response of IGP's Emergency and Seismic Alert Service in Real Time, must perform.

4. Concerning the Operator of the Center

The operator of the Center for Processing Seismic Signals in Real Time is responsible for fulfilling the goals of IGP's Emergency and Seismic Alert (in real time) Service. Guidelines are given below which will help the service to better fulfill its task:

A. The locating of earthquakes

The way in which the various steps for locating earthquakes detected by the Seismic Telemetry Network proceed, is described in the Autoseis Manual (Autoseis Reference Manual, 1983). However, in the following lines a summary is given for the following cases:

i. *The Operative Autoseis System*

- Identify the earthquake: small, medium, or large, and whether it is a local or regional earthquake. In the case of it being noise, erase all the areas where it registered. In SCAN with DE and DH "to delete it" likewise from Keymaster.

- The earthquake processed in real time by the system will have to be checked on the Tektronix, verify beforehand whether the time has been decoded (KEYMASTER), not to be decoded (see B), otherwise, check the P phases which the system has taken, read the possible S phases, modify the weight and polarity options if it is necessary and go back to locating it.

- Utilize all the SCAN routines.

- Run the data obtained with the FASTHYPO1 program.

- If it is an earthquake which possibly has been recorded in Huancayo, Tacna, and/or Arequipa, request the information and recalculate the hypocenter.

- Compare the results and put the observations on the same output list.

ii. *The Inoperative or Non-Activated Autoseis System*

When the Autoseis System is not operative or the time has not been decoded.

- Proceed in obtaining the data off the seismograms from the recorders of the Central Seismic Station's analog recording system.

- Run FASTHYPO1 with the data obtained.

- When the earthquake is of a magnitude greater than 4.0 mb or has been felt somewhere in Perú, prepare the Preliminary Seismic Bulletin and immediately report it to Defensa Civil (Civil Defense), writing down the time and the person who received it. The Bulletin must go out with the name and signature of the operator-analyst.

- When the earthquake is located near an important city, make a phone call to this city or surrounding areas in order to evaluate the intensities. Write it down in the corresponding Preliminary Seismic Bulletin. The data file for the entering in to FASTHYPO1, load it into the EMERA file of the corresponding month.

iii. *Non-Operative PRIME Computer*

Proceed in obtaining data off the seismograms from the recorders of the seismic station's analog recording system.

Proceed in obtaining the hypocenter on the Heathkit, only when stable conditions

of electric energy exist, otherwise utilize another calculating unit. Also, use the 3-pt. graphical or compass method.

If the earthquake is of a magnitude greater than 4.0 mb or has been felt somewhere in Perú, prepare the Preliminary Seismic Bulletin and immediately report it to Defensa Civil (Civil Defense), writing down the time and the person who received it. The Bulletin must go out with the name and signature of the operator-analyst. If the earthquake is located near an important city make a telephone call to this city or the surrounding areas in order to evaluate the intensities. Write it down in the corresponding Preliminary Seismic Bulletin.

As soon as the PRIME is operative the epicenters of the calculated earthquakes will be processed with FASTHYPO1 and loaded into EMERA. **THIS IS THE RESPONSIBILITY OF EACH ANALYST WHEN THIS HAPPENS DURING HIS SHIFT.**

B. Preliminary Seismic Bulletins

Once the earthquake is located, the Preliminary Seismic Bulletin of this event with the results from the computations carried out is prepared. These computations will be completed with the microseismic intensities information which would have been obtained from populated centers neighboring the epicenter.

The Bulletin must be identified by a correlation number, by having the last two digits as new initials. This document, likewise, will have to be signed by the Operator-Analyst.

C. The Transmission and Dissemination of the Bulletins

i. Once the Preliminary Seismic Bulletin is prepared, the Defensa Civil (Civil Defense) will have to be informed, for this reason the Bulletin must be read. The time of the information's transmission and the name of the person receiving the Bulletin must be written down. In the event that no one answers the phone at the Defensa Civil (Civil Defense), write down this fact.

ii. In cases where the media solicits information about a felt seismic event, the operator would confine himself to reading the Seismic Bulletin, while making the same annotations which he made in the Defensa Civil (Civil Defense) instance. The operator must abstain from making comments.

iii. Make the occurrence of the seismic event known to la Presidencia Ejecutiva (the Executive Chairmanship), Dirección Técnica (Technical Department), la Dirección de Servicios Técnicos, y Física de la Tierra Sólida (the Technical Services and Solid Earth Physics Departments) in the cases where the magnitude is larger than 4.7 mb.

D. Response to Tsunami or Seaquake Alerts

IGP is part of the Alert System concerning Tsunamis in the Pacific. It is very important to promptly answer the requests which are received.

The reception and response procedures are described in the Appendix.

i. When the earthquake is strong and it occurs in the ocean next to the Peruvian shores, one must begin a message.

E. Strong Regional Earthquakes

In case there is a strong regional earthquake call CERESIS, limiting oneself to giving the P and S arrivals from the seismic stations with the universal code, which is the one that appears on the list of stations as Cod. 2. If one can read a S phase, it is possible to approximately estimate what the distance is in degrees to the epicenter, and depending on the arrivals at the stations, the direction of the earthquake. This information will be given to CERESIS and to Defensa Civil (Civil Defense) if they solicit it. Also prepare a Tsunami message and transmit it to Corpac (see Appendix 1).

F. Seismogram Analysis and Information File

i. Analyze and process the Central Seismic Station's seismograms corresponding to his shift: amplitude, periods, etc. The final data must be entered in to the Seismic Bulletin File - ISC Format.

ii. When necessary or when the tape on which the earthquakes are being recorded is full: Make CHANGETAPE, and immediately make DAYTAPE.

iii. Make the earthquake file (ARCHTAPE). Preferably in the afternoon or at night. The loading of the earthquakes on the disk (DAYTAPE) and ARCHTAPE will be the responsibility of one person, in rotating shifts of a month's duration. If by some emergency DAYTAPE has become full, advise the person responsible with a note and write it down in the log notebook.

iv. Check the "CATALOG" (make sure that no events are introduced repeatedly).

v. Append to the EMERA file the data from NNA, HUA, and any other seismic station depending on the location of the earthquake.

G. Other Chores

i. For the fulfilling of goals set within the Emergency and Seismic Alert Service, the operator-analyst will have to complete the tasks which his immediate superior assigns to him.

ii. With the support of the assistant Operator, the operator will watch out for keeping the Central Seismic Station in good operating condition: analog recorders and telemetry equipment.

iii. Upon starting his shift, taking over the duties of the operator that he replaces. After ending his shift, delivering his duties to the one who follows. In both cases they will have to sign log-in and acceptance of duty sheets, while verifying the condition of the equipment or goods which they receive.

iv. The operator on duty must not allow material, work tools, computer items, etc. to leave the Computer Center.

5. Concerning the Assistant Operator

He is an assistant of the Emergency and Seismic Alert Service and is at the service of the operator of the Center for Processing Seismic Signals in Real Time. His principal chores are:

i. To keep an eye on the proper operation of the analog recorders in the Central Seismic Station's recording room.

ii. To change the recording paper and "to fasten it". After taking the record from the drum, he will have to write down:

- the hour and minute of the last time mark
- the date and name of the station
- the gain and filters of the signal processor

After putting the paper on the drum he will have to write down:

- the initials of the one who changes the records
- the name of the station
- the gain and filters of the seismic amplifier
- the hour and minute of the first time mark.

iii. In the event of an earthquake he will have to collaborate with the Center's operator, in particular:

- answering the phones at the Computer Center
- taking note of information from the radio concerning microseismic intensities
- calling the Huancayo seismic station
- making a phone call to the Tacna and Arequipa seismic station, when the earthquake occurs south of the telemetry network.

iv. When some piece of equipment from the Central Seismic Station is working poorly, he will have to go and get the electronic technician on duty for him to repair the defective unit prior to the authorization of the Center's operator.

v. If the computer is functioning poorly and it requires the technician on duty from la Dirección de Informática (the Information Department), he will have to go and get him prior to the authorization of the Center's operator.

vi. During the night, watching over the premises.

vii. At the change of duty, at 7–8 pm, bringing the operator on-duty, within the city limits, prior to telephoning the operator.

viii. Taking the operator on-duty, who leaves at 8–9 pm, to his dwelling within the city limits or to some place where he can make use of public transportation when his dwelling is outside the city limits.

In the event of any problems or abnormalities, the Center's operator will have to be notified.

6. Concerning the Person Responsible for Keeping the Computer Center Operative

The technician, responsible for keeping the Computer System of the Center for Automatic Processing of Seismic Signals in Real Time operative, is nominated by the Director of La Dirección de Informática (the Information Department) from among his staff.

His principal tasks are:

i. Keeping the PRIME computer and peripherals functioning properly.

ii. Assisting and instructing the Center's operator in the particulars of the Autoseis System.

iii. Instructing and assisting the Center's operator when software problems arise which he can not resolve.

iv. Being willing to be moved around by the assistant on duty (Driver) at any moment.

In the event of any problems or abnormalities with the units for processing simple data, as well as with the software he will have to inform the Center's operator and his immediate superior.

7. Concerning the Person Responsible for Keeping the Recording System Operative

The person responsible for keeping the analog recording system operative is the electronic technician on duty. He is designated by the authorized person from the Electronic Laboratory and Central Seismic Station. He will be available for pick up by the driver at any time of the day, according to the need for his service.

His principal responsibilities are the following:

i. Keeping the analog recording units, the signal processors, and complementary equipment in proper operating condition.

ii. Making sure that, in the event of a blackout, the battery supply is in optimum condition.

iii. Verifying that the Honda generator is operative and has enough fuel, so that the assistant operator on duty can charge the battery supply, if it would be necessary.

iv. Making sure that there is enough paper, alcohol, shellac, etc. for the Central Seismic Station's recorders.

v. Making sure that the records are of good quality.

vi. Giving out the appropriate instructions for the proper operation of the analog recording system.

vii. Delivering the Central Seismic Station's seismograms in the form which the boss of the Seismological Service designates.

Note: This manual was based upon the Manual on hand at la Dirección de Servicios Técnicos: Area de Servicio Sismológico (the Technical Services Department: Seismological Service Area).

A[illegible]

APPENDIX

I.- INSTRUCCIONES A SEGUIR EN CASO DE MENSAJES TSUNAMI

INSTRUCTIONS TO FOLLOW IN THE EVENT OF TSUNAMI MESSAGES

1.0 Los mensajes tsunami llegan al Instituto Geofisico del Peru (IGP) desde Honolulu a través de los canales: COFPAC-DUMY-IGP por el telefono magnetico y COFPAC-IGP por el telefono normal.

2.0 Hacer uso del telefono normal solo cuando el magnetico este inoperativo.

3.0 Los mensajes Tsunami Dummy deben ser contestados inmediatamente sin cortar la comunicación ni al telefono magnetico o el normal.

4.0 Los mensajes tipo boletin no se contestan

5.0 Los mensajes de alerta real deben ser comunicados al Presidente Ejecutivo, Director Tecnico y Director de Servicios Tecnicos, inmediatamente de ser recepcionados

6.0 Anotar los mensajes recibidos con sus respectivas respuestas en el cuaderno de Mensajes.

7.0 Anotar la hora de recepcion y transmision de los mensajes en el cuaderno.

II. MENSAJES TSUNAMI

TSUNAMI MESSAGES

A. MENSAJES DUMMY

1.0 Dummy

2.0 Dummy prueba de comunicaciones

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B. MENSAJE REAL

C. MENSAJES TIPO BOLETIN

1.0 Boletin de un sismo en investigacion

2.0 Boletin informativo

A. MENSAJES 'DUMMY'

1.0 Mensaje "Dummy"

i) Texto del mensaje que se recibe:

TSUNAMI DUMMY

ALL STATION REPORT [illegible] OF RECEIPT OF THIS MESSAGE AND SIGN

ii) Respuesta al mensaje dummy

FROM MAREMOTO I.G.P

TO PACIFIC TSUNAMI WARNING CENTER

TSUNAMI DUMMY YOURS (separar el DIA HORA Y MINUTO dado arriba)

RECEIVED AT DIA HORA MINUTO (del reloj satelite)

Signa(nombre del que contesta)

2.0 Mensaje dummy prueba de transmision

i) Texto del mensaje que se recibe.

FROM THE PACIFIC TS[illegible] WARNING CENTER

TSUNAMI DUMMY.

THIS IS A TEST TO D[illegible] TRANSMISSION TIME INVOLVED IN

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DISSEMINATION OF TSUNAMI WATCH AND WARNING INFORMATION.
ALL

ADDRESSES ADVISE PHONE PACIFIC TSUNAMI WARNING CENTER OF

TIME OF RECEIPT OF THIS MESSAGE AND SIGN NORMAL ROUTINE

PROCEDENCE THIS TEST ONLY

STOP.

ii) Respuesta al mensaje [illegible] prueba de comunicación

TO PACIFIC TSUNAMI WARNING CENTER

TSUNAMI DUMMY. YOUR 231901Z RECEIVED 231907Z

Nota.- Tiempo del reloj [illegible]

B. MENSAJE REAL

1.0 Mensaje real:

i) Texto que se recibe:

FROM PACIFIC TSUNAMI WARNING CENTER

TO MAREMOTO INSTITUTO GEOFISICO DEL PERU

REQUEST INMEDIATE RELAY INFO ON EARTQUAKE OF

1422Z THIS DATE. HONOLULU 141300Z

ii) Respuesta al mensaje real:

TO PACIFIC TSUNAMMI WARNING CENTER

TSUNAMI. EP143228Z [illegible] MAREMOTO OBSERVATORY
Signed

Nota.- En el caso de que el sismo no esta registrado en ningun sismo- grama Recomendar:

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YOUR TSUNAMI REQUEST NOT BE LISTENED AT MAREMOTO

C. MENSAJES TIPO BOLETIN

1.0 Mensaje tipo boletin en investigacion

i) Texto que se recibe:

PACIFIC TSUNAMI WARNING CENTER/NOAA/NWS BULLETIN NO._____
AN EARTHQUAKE RECORDED BY THE PACIFIC TSUNAMI WARNING CENTER

OCCURRED ADT_____UTC _____ EDT_____PST_____SEP IN THE VICINITY
OF_____
THE EARTHQUAKE MEASURED _____ON THE RICHTER SCALE AND
WAS LOCATED NEAR_____LATITUDE _____LONGITUDE
THIS IS AN ADVISORY RESPECT AN INVESTIGATION IS UNDERWAY
TO DETERMINE THE TSUNAMI THREAT. YOU WILL BE KEPT INFORMED
AS ADDITIONAL INFORMATION BECOMES AVAILABLE

ii) No se da respuesta

2.0 Mensaje tipo boletin informativo

i) Texto que se recibe:

PACIFIC TSUNAMI WARNING CENTER/NOAA/NWS BULLETIN AN
EARTHQUAKE RECORDED BY THE PACIFIC TSUNAMI WARNING CENTER

OCURRE AT____UTC_____ EDT_____SEP IN THE VICINITY OF

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THE EARTHQUAKE MEAS[illegible]_____ [illegible] THE RICHTER SCALE AND

WAS LOCATED NEAR_____ AT [illegible] E_____LONGITUDE.

THE MAGNITUDE WAS N[illegible] SUFFICIENT TO GENERATE A PACIFIC WIDE

TSUNAMI.

ii) No se da respuesta.

LO:ma.
280987

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A N E X O - B

APPENDIX - B

INSTITUTO GEOFISICO DEL PERU
Geophysical Institute of Peru
GEOFISICA APLICADA
Applied Geophysics

Technical Report
INFORME TECNICO

PROYECTO RED SISMICA AID/CIW
AID/CIW SEISMIC NETWORK PROJECT

PERFORACION DE POZOS PARA LA INSTALACION DE EXTENSOMETROS DE VOLUMEN
DRILLING OF HOLES FOR THE INSTALLATION OF VOLUME STRAINMETERS
POZO : LACHAY
HOLE: LACHAY

Por: Felix Monge Castillo
(BY):

Lima, Febrero 1987
FEBRUARY

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1.2 Ubicacion y acceso
LOCATION AND ACCESS

2. PERFORACION
DRILLING

3. PRUEBA DE VERTICALIDAD Y ALINEAMIENTO
VERTICALITY AND ALIGNMENT TEST

4. PRUEBA DE PROFUNDIDAD
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5. CONCLUSIONES
CONCLUSIONS

ANEXO . Registro geologico de perforacion
APPENDIX: GEOLOGICAL RECORD OF DRILLING

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1 INTRODUCCION

Este pozo denominado L-1-IGP, constituye el segundo de una serie de tres realizados durante la campaña 1986, en el marco del PROYECTO RED SISMICA AID/CIW, para la instalacion de extensometros de volumen

El pozo esta localizado en la zona de Lachay, Huacho, a 107 km de Lima.

La perforacion fue ejecutada por la Cia. GEOTEC S.A., segun contrato suscrito con el Instituto Geofisico del Peru (IGP) el 13.11.86.

La perforacion se hizo en roca granitica con recuperacion parcial de testigos

La profundidad programada fue de 100 m, pero se llego a 100.40 m con diametro NQ (3 56"). Solamente los testigos del tramo comprendido entre los 90 y los 100.40 m fueron recuperados y sellados en tres cajas de madera, las mismas que fueron entregadas a la comision receptora del IGP.

Se revistio con cemento desde 0.00 a 90.00 m dejando como proteccion del cuello del pozo una tuberia de fierro de 1.16 m (casing) de longitud y 5.50" de diametro.

Los trabajos se iniciaron el 03.12.86 culminando el 08.12.86, y la entrega del pozo se efectuo el 09.12.86.

1.1 OBJETIVO

Este sondaje tiene como principal objetivo instalar un extensometro de volumen con sensibilidad del orden del 10^{-9}, a fin de detectar la deformacion en la corteza terrestre producida por la continua accion de los fuerzas tectonicos en el interior de la tierra

1.2 UBICACION Y ACCESO

El sitio del pozo se localiza en Lachay y corresponde al distrito de Huaral/Sayan, provincia de Huacho, departamento de Lima. Su posicion geografica esta

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definida por las coordenadas 11o21'27"S y 77o23'13"W.

El acceso al punto es por el km 107 de la carretera Panamericana norte, pasando el desvio hacia las "Lomas de Lachay". Entrando al campamento "Dona Maria" del Ministerio de Transportes se penetra sobre una pista afirmada aproximadamente unos 4 km en direccion norte para llegar al lugar indicado, en el pie de la falda oeste de las Lomas de Lachay.

En este lugar aflora nitidamente un macizo granitico, el cual servira de emplazamiento al pozo. Este granito aparece en la vecindad del pozo cortado por diques andesiticos E-W

2. PERFORACION

El tramo comprendido entre 0.00 y 90.29 m se perforo con el sistema "down the hole" con "air hammer" (DHH), con diametro 4.50" en roca granitica, luego continua la perforacion con "diamond drill" (DD) 4.50" de diametro hasta 92.21 m.

Debido a que la roca se presenta muy dura y hay poco avance se cementa desde 0.00 a 92.21 m. Despues de perforar el pozo con DD 4.50" se continua la perforacion en roca con el mismo sistema hasta 100.40 m pero con NC=3.56" de diametro. De 0.00 a 90.29 m no hay recuperacion de testigos, pero si de 90.29 a 100.40 m.

En el tramo perforado desde 92.21 a 100.40 m debido a que el granito se encuentra sano y sin alteraciones, lo cual le da alta competencia, se ordena no inyectar cemento

Finalmente, se instala un tubo de fierro de 5.50" y de 1.16 m de longitud para el cuello del pozo.

La litologia segun el registro de "logeo" y a partir de observaciones macroscopicas indican:

- De 0.00 a 90.29 m se tiene roca intrusiva: granito en estado triturado y en polvo de silice, color blanco con poca alteracion. En este tramo no hubo recuperacion de testigos.

- De 90.25 a 100.40 m el material corresponde a granito gris rosaceo, en estado totalmente sano y competente, con recuperacion de core. Esta roca por sus caracteristicas mineralogicas y de gran contenido de cuarzo aprox. 60 por ciento, se califica como granito cuarcifero o cuarzo-granito.

3 PRUEBA DE VERTICALIDAD Y ALINEAMIENTO

Durante la instalacion del equipo de perforacion se verifico personalmente la nivelacion y verticalidad del eje de perforacion.

Asimismo, en el acto de entrega-recepcion del pozo se hizo la prueba respectiva. Para esta prueba se coloco en el pozo una sonda conformada por tuberia acoplada con dos tubos de 2.75 m y uno de 3.05 m. Todo ello suspendido del cable de winche, se bajo hasta el fondo del pozo y luego se elevo en presencia de las comisiones del IGP y GEOTEC S.A. Durante la prueba se observo el libre paso del sistema a lo largo del pozo.

4. PRUEBA DE PROFUNDIDAD

Para esta prueba se coloco en el pozo toda la columna de tuberia utilizada durante la perforacion, acoplandose los tubos sucesivamente de uno en uno. Finalmente se sumo la totalidad de tubos descontandose la tuberia sobrante.

Durante la prueba se constato una profundidad real de 102.20 m tomando como base de referencia para la boca del pozo, el borde superior de la caja metalica de proteccion

5. CONCLUSIONES

5.1 Para la perforacion de este pozo se aplico el sistema "down de hole" con "air hammer" (DHH) con 4.50" de diametro y despues "diamond drill" (DD) 4.50" y 3.56"

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de diametro.

5.2 El revestimiento se hizo con cemento en todo el pozo, a excepcion del tramo 92.21 a 100.40 m, en el cual la roca no necesitaba por mostrarse sana y sin alteraciones, y en el cuello del pozo con tubo de fierro de 5.50" de diametro con 1 16 m de longitud.

5.3 La perforacion fue realizada sobre roca intrusiva la que por su composicion mineralogica se define como granito cuarcifero o cuarzo-granito.

5.4 El registro litologico indica granito cuarcifero (Qz = 60 por ciento) color gris-rosacea y textura faneritica en todo el sondaje.

5.5 Solamente fue posible obtener core en los ultimos 10 m, debido a que el sistema DHH produce muestras trituradas y en polvo de silice. Asi se verifica roca totalmente sana, sin fracturas, diaclasas, fallas y alteraciones, etc.

5.6 No se ha detectado indicios de agua en el sondaje.

5.7 La roca muestra una optima calidad y alta competencia. La extrema dureza de esta roca permitio poco avance con DD, por lo que fue necesario un continuo chancado de brocas.

5.8 La roca muebla del pozo, asi como su entorno esta excento de riesgo geologico, debido a que se encuentra en una zona relativamente plana y sin precipitaciones pluviales importantes.

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INSTITUTO GEOFISICO DEL PERU — DPTO DE GEOFISICA APLICADA

^210 REGISTRO DE PERFORACION

SONDAJE: L-1-IGP
ELEVACION:
COORDENADAS:
LATITUD: 11°21'27"S
LONGITUD: 77°23'13" W
INCLINACION: 90°
DIAMETRO: 4 1/2"

PROYECTO: IGP 10101 - EXTENS. VOLUMEN
PERFORADO POR: GEOTEC S.A.
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA:
FECHA INICIAL: 04.12.86
FECHA FINAL: 08.12.86
ESCALA VERTICAL: 1/75

FECHA	PROF Y GROSOR	MUES-TRA	RECU-PERA-CION	CARACTERISTICAS: CO-LOR	INT-EMP	FRA-CTU	DIA-CLA	F-A	DESCRIPCION LITOLOGICA	SIMBO-LOGIA	OBSERVACION
04.12.86	0.00m										
	1.00										* 14 corridas en el turno de día.
	2.00								Cuarzo Granito.		
	3.00								estado físico: triturado, en partículas granulares y en polvo de sílice.		* 12 corridas en el turno de noche
	4.00		0%	blanco	?	?	?	?			L. c/corrida ≅ a 2.74 m.
	5.00										
	70.										
	71.										
	72.										
	73.										
05.12.86	73.85										
			0%	blanco	?	?	?	?	Cuarzo Granito granular y en polvo de sílice		* 6 corridas en el turno de día.
	77.00										

F. M. / J. C. G. A. — REALIZADO POR: Félix Monge C. — FECHA: 05.12.86

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INSTITUTO GEOFISICO DEL PERU — DPTO DE GEOFISICA APLICADA

210 REGISTRO DE PERFORACION

SONDAJE: L-1-IGP
ELEVACION:
COORDENADAS:
LATITUD: 11° 21' 27" S
LONGITUD: 77° 23' 13" W
INCLINACION: 90°
DIAMETRO: 4 1/2" / 356"

PROYECTO: IGP 10101D - EXTENS. VOLUM.
PERFORADO POR: GEOTEC S.A.
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA: 100.40
FECHA INICIAL: 04.12.86
FECHA FINAL: 09.12.86
ESCALA VERTICAL: 1/75

FECHA	PROF Y GROSOR	MUESTRA	RQD RECUPERACION	CARACTERISTICAS CO-LOR	INTEMP	FRACTU	DIACLA	F A	DESCRIPCION LITOLOGICA	SIMBOLOGIA	OBSERVACION
	77.00										
	78.										
	89.		0%	blanco	–	–	–	–	Granito granular y en polvo de silica		
05.12.86	90. 90.29										
	91.09	M1	100%	Gris. Rosa. Geo.	–	–	–	–	Cuarzo Granito		Roca de alta dureza
	91.84	M2	100%	Grisác. Rosac.	–	–	–	–	Cuarzo Granito		Estado físico SANO
06.12.86	92.19	M3	100%	"	–	–	–	–	"		"
08.12.86	92.54	M4	100%	"	–	–	–	–	"		"
	93.42	M5	100%	Grisác. rosac.	–	–	–	–	Cuarzo Granito		"
	93.92	M6	100%	"	–	–	–	–	Cuarzo Granito		Totalmente sano (CORB)
09.12.86	95.11	M7	100%	Grisác. Rosac.	–	–	–	–	Cuarzo Granito		"
	95.76	M8	100%	"	–	–	–	–	"		"
	95.96	M9	100%	"	–	–	–	–	"		"
	97.21	M10	100%	"	–	–	–	–	Cuarzo Granito		"
	98.16	M11	100%	"	–	–	–	–	"		"
	99.20	M12	100%	"	–	–	–	–	Cuarzo Granito		CORB TOTALMENTE SANO
10.12.86	100.10	M13	100%	"	–	–	–	–	Cuarzo Granito		"

F.M. / J.C.C.A. REALIZADO POR: Félix Monge C. FECHA

INSTITUTO GEOFISICO DEL PERU
GEOPHYSICAL INSTITUTE OF PERU

GEOFISICA APLICADA
APPLIED GEOPHYSICS

TECHNICAL REPORT
INFORME TECNICO

PROYECTO RED SISMICA AID/CIW
AID/CIW SEISMIC NETWORK PROJECT

PERFORACION DE POZOS PARA LA INSTALACION DE EXTENSOMETROS DE VOLUMEN
DRILLING OF HOLES FOR THE INSTALLATION OF VOLUME STRAINMETERS

POZO : SONGOS
HOLE: SONGOS

Por: Felix Monge Castillo
(BY):

Lima, febrero 1987
FEBRUARY

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1. INTRODUCCION

Este pozo denominado S-1-IGP, constituye el primero de una serie de tres realizados durante la campana 1986, en el marco del PROYECTO RED SISMICA AID/CIW: para la instalacion de extensometros de volumen.

El pozo se ubica en la localidad de Songos, Matucana, a 65 km de Lima.

La perforacion fue ejecutada por la Cia. CEOTEC S.A., segun contrato suscrito con el Instituto Geofisico del Peru (IGP) el 13.11.86.

La perforacion se hizo en roca granodioritica con recuperacion continua de testigos.

La profundidad programada fue de 100 m, pero se llego a 102.60 m. Solamente los testigos del tramo comprendido entre los 90.00 m y los 102.60 m fueron recuperados y sellados en cuatro cajas de madera, las mismas que fueron entregadas a la comision receptora del IGP.

Se revistio con cemento en toda la longitud perforada dejando como proteccion del cuello del pozo una tuberia de fierro de 8.50 m de longitud y 4.50" de diametro.

Los trabajos se iniciaron el 20.11.86 culminando el 28.11.86, y la entrega del pozo se efectuo el 29.11.86.

1.1 OBJETIVO

Este sondaje tiene como objetivo primordial instalar un extensometro de volumen con sensibilidad del orden del 10^{-9}, a fin de detectar la deformacion en la corteza terrestre producida por la continua accion de las fuerzas tectonicas en el interior de la tierra.

1.2 UBICACION Y ACCESO

El sitio del pozo esta ubicado en la localidad de Songos, y pertenece al distrito de Surco, provincia de Matucana, departamento de Lima. Su posicion geografica esta determinada por las coordenadas: 11o52'50"S y

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76o28'40"W.

Para llegar al lugar designado para el pozo se toma la carretera central pasando la Central Hidroelectrica Pablo Bonet hasta la localidad de Songos, km 65. De este punto se coge una trocha de acceso y se cruza un puente para llegar en "U" al final de la carretera antigua, abandonada, lugar precisado para el pozo.

En este lugar aflora un intrusivo granodioritico de regulares dimensiones. El extremo oeste de este cuerpo cristalino servira como emplazamiento del pozo.

2. PERFORACION

Se perforo desde 0.00 m a 15.95 m con "diamond drill" (DD), con diametro NCD de los cuales 8.50 m fueron en material fluvio-aluvial y 7.45 m en granodiorita con recuperacion de testigos.

Los primeros 8.50 m quedaron revestidos con entubado de 4.50" de diametro hasta roca firme. Posteriormente, se cementa la profundidad total y se reperfora con el mismo metodo.

Se continua con la perforacion en granodiorita desde los 15.95 m hasta los 102.60 m con diametro NC. Habiendose detectado por "logeo" entre los 90.00 a 100.00 m fracturamiento fuerte y falla a los 99.00 m se preciso profundizar hasta los 102.60 m para encontrar roca sana. Luego se cementa el pozo y se reperfora en su totalidad.

La litologia segun el registro de "logeo" y a partir de observaciones macroscopicas, indican :

- De 0.00 a 8.50 cubierta cuaternaria, conformada por sedimentos fluvio-aluviales correspondientes a la terraza T-1 del rio Rimac, con rodados de andesitas, porfido-andesiticos, cuarcitas y granodioritas.

- De los 8.50 a 17.00 m se tiene granodiorita con fuerte diaclasamiento sub-horizontal y angular con algunas fallas compatibles al sistema de diaclasas. El fracturamiento es

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minimo en este tramo y el intemperismo moderado a fuerte. Las diaclasas y fracturas presentan relleno de oxido de fierro.

- De 17.00 a 24.00 m la granodiorita muestra un fracturamiento sub-horizontal intenso y diaclasa angular en menor grado.

- De 24.00 a 41.00 m hay un diaclasamiento subangular intenso con pocas fracturas, veta de Qz y oxidos a los 35.00 m.

- De los 41.00 a 50.00 m la roca muestra diaclasamiento y fracturamiento sub-horizontal. El fracturamiento e intemperismo es fuerte en los tramos 41.20-42.20 m, 43.80-44.50 m, 47.20-47.60 m y, debil a moderado entre 44.50-47.60 m con epidotizacion.

- De 50.00 a 51.00 m la granodiorita se presenta sana.

- De 54.00 a 60.00 m el diaclasamiento y fracturamiento es alternado y subangular con presencia de minerales maficos.

- Entre los 60.00 a 96.00 m el fracturamiento es debil a moderado con fallas a los 64.60, 65.80 y 79.20 m con material brechoso y epidota. A los 67.00 m vetilla de sulfuro negro, a los 69.00 veta de turmalina y mineral mafico. A los 77.00 m se encuentran vetillas finas de Py y otros sulfuros. Algunas fracturas presentan relleno de calcita y minerales maficos.

- De los 96.00 a 99.60 m existe un fracturamiento intenso y sub-angular rellenados con calcita.

- Entre los 98.60 y 99.00 m existe una falla importante mineralizada con sulfuros de Cu, Pb, calcita y milomita.

- En el ultimo segmento 99.60-102.60 m la roca se encuentra poco fracturada y mas sana que el tramo anterior.

3. PRUEBA DE VERTICALIDAD Y ALINEAMIENTO

Durante la instalacion del equipo de perforacion se verifico personalmente la nivelacion y verticalidad del eje de perforacion.

Asimismo, en el acto de entrega-recepcion del pozo se realizo la prueba respectiva. Ello consiste en la colocacion en el pozo de una sonda conformada por tuberia acoplada con dos tubos de 2.75 m y uno de 3.05 m. Todo el sistema suspendido del cable de winche se bajo hasta el fondo del pozo y luego se elevo elevo en presencia de las comisiones del IGP y GEOTEC S.A. Durante la prueba se observo el libre paso del sistema a traves de todo el pozo.

el libre peso del sistema a traves de todo el pozo.

4. PRUEBA DE PROFUNDIDAD

Para esta prueba se coloco en el pozo toda la columna de tuberia utilizada durante el proceso de perforacion, acoplandose los tubos sucesivamente de uno en uno. Finalmente se sumo la totalidad de tubos descontandose la tuberia sobrante.

Para la profundidad total se tomo como base de referencia para la boca del pozo, el borde superior de la caja metalica de proteccion, constatandose una profundidad real de 102.40 m.

5 CONCLUSIONES

5.1 El sistema de perforacion aplicado en el presente pozo fue el "diamond drill" (DD) con diametro NC y NCD.

5.2 el revestimiento fue hecho con cemento en la totalidad del pozo y en el cuello con tubo de fierro de 4.50" de diametro con 8.50 m de longitud.

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5.3 La perforacion fue realizada sobre roca intrusiva, la cual segun su composicion mineralogica se define como granodiorita.

5.4 Segun el registro litologico los primeros 8.50 m corresponden a sedimentos fluvio-aluviales y de 8.50 a 102.60 m se tiene granodiorita color grisacea y textura faneritica.

5.5 La columna de core presenta un fracturamiento sub-horizontal y angular alternado con el diaclasamiento. Las diaclasas son persistentes hasta los 60.00 m, no asi en las fracturas que se mantienen hasta al final. Las fracturas generalmente aparecen con relleno de calcita y minerales oscuros.

El fallamiento es discontinuo siendo por lo general angular, y compatible con el sistema de fracturas y diaclasas, aparece a los 9.70, 11.60, 15.00, 16.00, 17.30, 29.60, 31.65, 40.15, 64.65, 65.80, 79.50 y 98.50 m, esta ultima la mas importante.

5.6 La alteracion se presenta persistente en los primeros 40.00 m, siendo esta principalmente por oxidacion, a traves del sistema de fracturas y diaclasas, lo que le da por tramos una coloracion amarillenta a la roca.

5.7 La mineralizacion esta signada por vetillas de sulfuro bruno a los 67.00 m, turmalina a los 69.00 y pirita con otros sulfuros a los 77.00 m.

En el tramo 98.60-99.00 m se presenta una falla mineralizada con sulfuros de Cu, Pb, calcita y milomita.

5.8 La calidad de la roca es moderada debido al fracturamiento y diaclasamiento constante en toda la columna litologica.

5.9 De acuerdo a la inspeccion geologica realizada con relacion al "afloramiento" destinado para emplazamiento del pozo, se observa que este corresponde al menor de tres grandes bloques vecinos, los cuales conforman un dique natural de soporte al gran deslizamiento que se superpone sobre estos. Por la ubicacion del bloque mueble parece ser el frente del primer deslizamiento de material aluvional, pues en la parte superior hay dos deslizamientos señalizados por los niveles de vegetacion.

A pocos metros se ubica un huayco muy importante que funciona todos los años.

En consecuencia, este pozo esta propenso á fenomenos geodinamicos por la ubicacion misma de la zona sobre tudo en los meses de verano: Huaycos y deslizamientos

INSTITUTO GEOFISICO DEL PERU — DPTO DE GEOFISICA APLICADA

^210 REGISTRO DE PERFORACION

SONDAJE: S-1-IGP
ELEVACION
COORDENADAS:
LATITUD: 11°52'50" S
LONGITUD: 76°28'40" W
INCLINACION: 90°
DIAMETRO: 4 1/2" / 3.56

Granodiorita
Diaclasam.
Fracturam.
Falla

PROYECTO: 101010 A10/CIN-IGP
PERFORADO POR: GEOTEC SA
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA: 102.60
FECHA INICIAL: 20.11.86
FECHA FINAL: 29.11.86
ESCALA VERTICAL: 1/75

FECHA	PROF Y GROSOR	MUES-TRA	RECU-PERA-CION	CARACTERISTICAS: CO-LOR	INT EMP	FRA CTU	DIA CLA	FA	DESCRIPCION LITOLOGICA	SIMBO LOGIA	OBSERVACION
	0.00m										
	5.45m.	M_1	75%						Material fluvio-aluvial, polimictico, con rodados de: Andesitas verdosas y violáceas, porfido Andesitico, cuarcitas, granodioritas, etc.		
	5.45										
	3.00m.	M_2	100%						Corresponde a la terraza T-1 Río: Rimac		
	8.45										
	2.75m.	M_3	100%						Roca granodiorita bastante alterada (óxidos de Fe), con diaclasamiento angular y fallamiento conspicuo, compatible con el sistema de diaclasas.		
	11.20										
	12.00		100%						Las diaclasas y fracturas presentan óxidos de Fe		

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INSTITUTO GEOFISICO DEL PERU — DPTO DE GEOFISICA APLICADA

^210 REGISTRO DE PERFORACION

SONDAJE: 3-7-IGP
ELEVACION:
COORDENADAS:
LATITUD: 11°52'50" S
LONGITUD: 76°28'40" W
INCLINACION: 90°
DIAMETRO: 3.56"

Granodiorita
Diaclasamiento
Fracturamiento
Falla

PROYECTO: 101010-AID/IGP-IGP
PERFORADO POR: GEOTEC SA
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA: 102.60
FECHA INICIAL: 20-11-86
FECHA FINAL: 22-11-86
ESCALA VERTICAL: 1/75

FECHA	PROF Y OROSOR	MUES-TRA	RECU-PERA-CION	CARACTERISTICAS: CO-LOR	INT EMP	FRA CTU	DIA CLA	F A	DESCRIPCION LITOLOGICA	SIMBOLOGIA	OBSERVACION
	12.00										
		M4	100%						Granodiorita alterada con fracturamiento y diaclasas horiz.		
	13.70										
	2.75m.	M5	100%						Granodiorita con gran diaclasamiento horizontal y angular. con pocas fallas		
21-11-86	16.45										
	1.65m.	M6	100%						Granodiorita con pocas fracturas y diaclasa.		
	18.10										
	1.00m.	M7	100%						Granodiorita con fractura horiz. y poca diaclas.		
22-11-86	19.10										
	1.40m.	M8	100%						Granodiorita con fracturamiento horizontal y poca diaclas.		
	20.50										
	1.45m	M9	100%						Granodiorita con diaclasam. horiz. y angular		
	21.95										
	1.65m.	M10	100%						Granodiorita con diaclasamiento angular		
	23.60										
	24.00										

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^210 REGISTRO DE PERFORACION

SONDAJE: S-I-IGP
ELEVACION:
COORDENADAS: /
LATITUD: 11°52'50" S
LONGITUD: 76°28'40" W
INCLINACION: 90°
DIAMETRO: 3.56"

Granodiorita
Diaclasam.
Fracturam.
Falla.

PROYECTO: 101010-A10/CIW-IGP
PERFORADO POR: GEOTEC SA
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA: 402.60
FECHA INICIAL: 20.11.86
FECHA FINAL: 29.11.86
ESCALA VERTICAL: 1/75

FECHA	PROF Y GROSOR	MUESTRA	CARACTERISTICAS: RECUPERACION	COLOR	INTEMP	FRACTU	DIACLA	FALLA	DESCRIPCION LITOLOGICA	SIMBOLOGIA	OBSERVACION
	24.00										
	1.65 / 25.25	M_{11}							Granodiorita		
	1.00m. / 26.25	M_{12}									
	1.15m. / 27.40m	M_{13}							diaclasamiento fuerte y constante de la roca, en forma subangular y angular		
	1.68m. / 29.08	M_{14}									
	0.87m. / 29.95	M_{15}									
	1.70m. / 31.65	M_{16}									
	1.40m. / 33.05	M_{17}									
	1.65m. / 34.75m	M_{18}							VETA de cuarzo alterada con oxidación		
	1.65m. / 36.00	M_{19}							roca alterada con óxidos de fe.		

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INSTITUTO GEOFISICO DEL PERU — DPTO DE GEOFISICA APLICADA

^210 REGISTRO DE PERFORACION

SONDAJE: S-1-IGP
ELEVACION:
COORDENADAS:
LATITUD: 11°52'50" S
LONGITUD: 76°28'40" W
INCLINACION: 90°
DIAMETRO: 3:56"

Granodiorita
Diaclasam.
Fracturam.
Falla

PROYECTO: 101010-AID/CIW-IGP
PERFORADO POR: GEOTEC SA
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA: 102.60
FECHA INICIAL: 20.11.86
FECHA FINAL: 29.11.86
ESCALA VERTICAL: 1/75

FECHA	PROF Y ESPESOR	MUESTRA	RECUPERACION	CARACTERISTICAS: COLOR	INTEMP	FRACTU	DIACLA	FA	DESCRIPCION LITOLOGICA	SIMBOLOGIA	OBSERVACION
	36.00 m.										
	36.40 m.										
	1.65m. 38.05	M_{20}									
	1.65 m. 39.70	M_{21}							alterada con oxidacion		
	1.50m. 41.20	M_{22}							falla		
	1.65m. 42.85	M_{23}							la roca muestra gran diaclasamiento		
	1.65m. 44.50	M_{25}							y fracturamiento alternados		
	1.65m. 46.15	M_{26}							y concordantes.		
	2.20m. 48.00	M_{27}									

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INSTITUTO GEOFISICO DEL PERU — DPTO DE GEOFISICA APLICADA

^210 REGISTRO DE PERFORACION

SONDAJE: S-1-IGP
ELEVACION:
COORDENADAS:
LATITUD: 11° 52' 50" S.
LONGITUD: 76° 28' 40" W
INCLINACION: 90°
DIAMETRO: 3 1/2"

Granodiorita
Diaclasam.
Fracturam.
Falla

PROYECTO: 101010-AID/CIW/-IGP
PERFORADO POR: GEOTEC SA
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA: 102.60
FECHA INICIA: 20.11.86
FECHA FINAL: 29.11.86
ESCALA VERTICAL: 1/75

FECHA	PROF Y GROSOR	MUES-TRA	RECU-PERA-CION	CARACTERISTICAS CO-LOR	INT EMP	FRA CTU	DIA CLA	F A	DESCRIPCION LITOLOGICA	SIMBOLOGIA	OBSERVACION
	48.00m.										
	48.35m.										
	1.65m. 50.00	M28							Granodiorita con fracturas y diaclasas subhoriz. con epidotiz		
	1.20m. 51.20	M29							Granodiorita Sana y sin alterac.		
	0.85m. 52.05	M30							"		
	1.70m. 53.75	M31							"		
	0.50m. 54.25	M32									
	1.55m. 55.80	M33							Granodiorita con diaclasamiento y		
	1.70m. 57.50	M34							fracturamiento alternados, y concordantes de subhorizontal a angular		
	1.00m. 58.50	M35									
	1.50m. 60.00	M36							con minerales ferromagnesianos.		

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^210 REGISTRO DE PERFORACION

SONDAJE: S-1-IGP
ELEVACION:
COORDENADAS:
LATITUD: 11°52'50" S
LONGITUD: 76°28'40" W
INCLINACION: 90°
DIAMETRO: 3.56"

Granodiorita
Diaclasam.
Fracturam.
Falla

PROYECTO: 101010-A10/CIW-IGP
PERFORADO POR: GEOTEC SA
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA: 102.60
FECHA INICIAL: 20.11.86
FECHA FINAL: 29.11.86
ESCALA VERTICAL: 1/75

FECHA	PROF Y GROSOR	MUES-TRA	CARACTERISTICAS: RECU-PERA-CION	CO-LOR	INT-EMP	FRA-CTU	DIA-CLA	F-A	DESCRIPCION LITOLOGICA	SIMBOLOGIA	OBSERVACION
	60.00										
	1.45m. 61.45	M37							poca sana y sin alteraciones.		
	1.30m. 62.75	M38							poco fracturamiento y horizontal.		
	1.65m. 64.40	M39									
	0.95m. 65.35	M40							granodiorita alterada con tart. gruesa y fallada.		
	1.50m. 66.85	M41							fallas delgadas con alteracion epidotiz.		
	1.60m. 68.45	M42							vetilla rellenado con sulfuro.		
	1.70m. 70.15	M43							veta de Turmalina y otros min. oscuros.		
	1.65m. 71.80	M44									
	72.00										

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^210 REGISTRO DE PERFORACION

SONDAJE: S-1-IGP
ELEVACION:
COORDENADAS:
LATITUD: 11°52'50"S
LONGITUD: 76°28'40"W
INCLINACION: 90°
DIAMETRO: 3.56"

Granodiorita
Diaclasam.
Fracturam.
Falla

PROYECTO: 101010-AID/CIW-IGP
PERFORADO POR: GEOTEC SA
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA: 102.60
FECHA INICIAL: 20.11.86
FECHA FINAL: 29.4.86
ESCALA VERTICAL: 1/75

FECHA	PROF Y GROSOR	MUES-TRA	RECU-PERA-CION	CARACTERISTICAS CO-LOR	INT EMP	FRA CTU	DIA CLA	F A	DESCRIPCION LITOLOGICA	SIMBOLOGIA	OBSERVACION
	72.00										
	1.60m. 73.40	M45							Diaclasa con epidotización.		
	1.65m. 75.05	M46							roca totalmente sana y sin alteraciones.		
	1.40m. 76.45	M47									
	1.40m. 77.85	M48							Veta delgada con mineralización de py y otros sulfuros.		
	1.70m. 79.55	M49							falla pequeña y con epidotización		
	1.55m. 81.10	M50							alteración blanquecina.		
	1.70m. 82.80	M51							Granodiorita con poco fracturamiento		
	1.70m. 84.00m.	M52							pero sub-horizontal.		

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INSTITUTO GEOFISICO DEL PERU — DPTO DE GEOFISICA APLICADA

210 REGISTRO DE PERFORACION

SONDAJE: S-1-IGP
ELEVACION:
COORDENADAS:
LATITUD: 11°52'50" S
LONGITUD: 76°28'40" W
INCLINACION: 90°
DIAMETRO: 3.56"

Granodiorita
Diaclasam.
Fracturam.
Falla

PROYECTO: 101010-A10/C1W-IGP
PERFORADO POR: GEOTEC S.A.
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA: 102.60
FECHA INICIAL: 20.11.86
FECHA FINAL: 29.11.86
ESCALA VERTICAL: 1/75

FECHA	PROF Y GROSOR	MUESTRA	RECUPERACION	CARACTERISTICAS: COLOR	INTEMP	FRACTU	DIACLA	FA	DESCRIPCION LITOLOGICA	SIMBOLOGIA	OBSERVACION
	84.00m.										
	84.50										
	1.25m. 85.75	M_{53}							granodiorita con fractura		
	1.65m. 87.40	M_{54}							nivel subhorizontal		
	1.30m. 88.70	M_{55}							epidotización y poro sulfuros.		
	1.70m. 90.40	M_{56}							fractura con relleno de calcita		
	1.20m. 91.60	M_{57}									
	1.10m. 92.70	M_{58}							fractura con relleno de calcita y mineral oscuro		
	0.75m. 93.45	M_{59}									
	1.45m. 94.90	M_{60}							granodiorita con poro		
	1.65m 96.00m	M_{61}							fractura con relleno angular.		

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INSTITUTO GEOFISICO DEL PERU — DPTO DE GEOFISICA APLICADA

^210 REGISTRO DE PERFORACION

SONDAJE: S-1-IGP
ELEVACION:
COORDENADAS:
LATITUD: 11°52'50"S
LONGITUD: 76°28'40"W
INCLINACION: 90°
DIAMETRO: 3.56"

Granodiorita
Diaclasam.
Fracturam.
Falla.

PROYECTO: 101010-AID/CIW-IGP
PERFORADO POR: GEOTEC SA.
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA: 102.60
FECHA INICIAL: 20.11.86
FECHA FINAL: 29.11.86
ESCALA VERTICAL: 1/75

FECHA	PROF Y GROSOR	MUESTRA	RECUPERACION	CARACTERISTICAS: COLOR	INTEMP	FRACTU	DIACLA	FA	DESCRIPCION LITOLOGICA	SIMBOLOGIA	OBSERVACION
	96.00 m										
	96.55m								fractura con relleno de calcita		
	1.70m. 98.25	M62							fisuras con relleno de calcita		
	0.75m. 99.00	M63							falla mineralizada con sulf. de Cu, Pb, calcita y milonita		
	1.00m. 100.00	M64							roca presenta poco fracturamiento y sin alteraciones.		
	1.00m. 101.00	M65									
	1.60m. 102.60	M66									

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INSTITUTO GEOFISICO DEL PERU
GEOPHYSICAL INSTITUTE OF PERU

GEOFISICA APLICADA
APPLIED GEOPHYSICS

TECHNICAL REPORT
INFORME TECNICO

PROYECTO RED SISMICA AID/CIW
AID/CIW SEISMIC NETWORK PROJECT

PERFORACION DE POZOS PARA LA INSTALACION DE EXTENSOMETROS DE VOLUMEN
DRILLING OF HOLES FOR THE INSTALLATION OF VOLUME STRAINMETERS

POZO : PAMPA-BLANCA
HOLE: PAMPA-BLANCA

Por: Felix Monge Castillo
(BY):

Lima, enero 1987
JANUARY

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I N D I C E
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1. INTRODUCCION

Este pozo denominado PS-1-IGP, constituye el tercero de una serie de tres realizada durante la campana 1986, en el marco del PROYECTO RED SISMICA AID/CIW, para la instalacion de extensometros de volumen.

El pozo se ubica en la localidad de Pampa-Blanca, Castrovirreyna, a 137 km de Pisco.

La perforacion fue ejecutada por la Cia. GEOTEC S.A., segun contrato suscrito con el Instituto Geofisico del Peru (IGP) el 13.11.86.

La perforacion se hizo en roca granodiorita con recuperacion parcial de testigos.

La profundidad programada fue de 100 m, pero se llego a 101.27 m con diametro NC (3.56"). Solamente los testigos del tramo comprendido entre los 90 y los 101.27 m fueron recuperados y sellados en cuatro cajas de madera, las mismas que fueron entregadas a la comision receptora del IGP.

Se revistio con cemento en toda la longitud perforada dejando como proteccion del cuello del pozo una tuberia de acero de 3.30 m de largo y 4.50" de diametro (O).

Los trabajos se iniciaron el 11.12.86 culminando el 29.12.86, y la entrega del pozo se efectuo el 30.12.86.

1.1 OBJETIVO

Este sondaje tiene como principal objetivo instalar un extensometro de volumen con sensibilidad del orden del 10^{-}, a fin de detectar la deformacion en la corteza terrestre producida por la continua accion de las fuerzas tectonicas en el interior de la tierra.

1.2 UBICACION Y ACCESO

El sitio prefijado para el pozo esta ubicado en el distrito de Pampa-Blanca, provincia de Castrovirreyna, departamento de Huancavelica. Su posicion geografica esta dada por las coordenadas 13o29'27"S y 75o28'31"W.

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La accesibilidad es por la carretera Panamericana sur hasta poco antes del rio Pisco. De este punto, se toma la carretera Libertadores que conduce a Castrovirreyna hasta llegar a una bifurcacion. Aqui se opta por el ramal izquierdo llegando finalmente a Pampa-Blanca, km 137, 12 km aprox. antes de Ticrapo y sobre la margen derecha de la carretera.

El pozo se emplaza sobre un intrusivo grano-dioritico, el cual conforma el flanco izquierdo del valle del rio Chilis (tributario del rio Pisco).

2. PERFORACION

El segmento inicial de 0.00 a 3.00 m se perforo con el sistema "Down the hole" con "air hammer" (DHH) en material aluvial. Este tramo se cementa y luego se reperfora con "diamond drill" (DD), esta operacion se realizo en dos partes: 1) de 0.00 a 1.65 y 2) de 1.65 a 3.00.

Se continua la perforacion con DHH en granodiorita desde los 3.00 hasta los 40.21 m con diametro 4.50" obteniendose testigos triturado y en polvo. Posteriormente, se cementa totalmente y se reperfora con DD hasta 3.30 m, profundidad a la cual se revista con tuberia de fierro de 4.50" O. Se sigue la reperforacion hasta llegar a los 40.21 m, desde aqui se continua perforando en granodiorita con DD diametro NC=3.55" hasta los 101.27, con recuperacion de core desde los 90.00 m

En razon de que el tramo 97.00-97.70 m se presenta bastante fracturado y habiendose registrado entre 97.70-98.20 m una estructura rellenada con cuarzo, calcita y alteracion se profundizo hasta 101.27.

Finalmente se inyecta cemento de acuerdo a las especificaciones tecnicas solamente en el segmento restante 40.21-101.27 y, posteriormente, se reperfora en su totalidad.

La litologia segun el registro de "logeo" y a partir de observaciones macroscopicas, indican lo siguiente:

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- De 0.00 a 3.00 m el material corresponde a sedimentos aluviales.

- De 3.00 a 90.00 m la roca granodiorita presenta mucho fracturamiento angular, oxidos de Fe y alteracion hidrotermal.

- De 90.00 a 91.34 m continua granodiorita con menor fracturamiento angular.

- De 91.34 a 93.42 m la granodiorita tiene un color grisaceo y se muestra bastante sana.

- De 93.42 a 98.25 m la roca se presenta muy fracturada, con pequenas fallas a los 95.00, 97.00 y 98.00, vetillas de cuarzo y calcita a los 97.90 y 98.10

- De 98.25 a 100.00 la granodiorita se encuentra muy sana y sin alteraciones.

- De los 100.00 a 101.27 m la roca presenta poco fracturamiento.

3. PRUEBA DE VERTICALIDAD Y ALINEAMIENTO

Durante la instalacion del equipo de perforacion se verifico personalmente la nivelacion y verticalidad del eje de perforacion.

Asimismo, en el acto de entrega-recepcion del pozo se realizo la prueba respectiva. Ello consiste en la colocacion en el pozo de una sonda conformada por tuberia acoplada con dos tubos de 2.75 m y uno de 3.05 m. Todo el sistema suspendido del cable de winche se bajo hasta el fondo del pozo y luego se eleva.

Durante la prueba los miembros de la comision del IGP y GEOTEC S.A. observaron el libre peso del sistema a traves de todo el pozo.

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4. PRUEBA DE PROFUNDIDAD

Para esta prueba se coloco en el pozo toda la columna de tuberia utilizada durante el proceso de perforacion, acoplandose los tubos sucesivamente de uno en uno. Finalmente se sumo la totalidad de tubos descontandose la tuberia sobrante.

Durante la prueba se constato una profundidad real de 100.66 m con diametro final de NC, contados desde la base del tubo que sobresale del pozo.

5. CONCLUSIONES

5.1 Este pozo sufrio tres cambios en su ubicacion. Los dos primeros en la terraza T-1 del rio Chilis y el ultimo al pie de un afloramiento grano-dioritico. Estos cambios se debieron a la gran potencia del material fluvio-aluvial atravesado y a problemas derivados de orden tecnico.

5.2 En la perforacion del pozo se aplico inicialmente el sistema "down de hole" con "air hammer" (DHH) y despues con "diamond drill" (DD).

5.3 El revestimiento se hizo con cemento en toda su longitud y en el cuello del pozo con tubo de fierro de 4.50" de diametro y 3.30 m de longitud.

5.4 La perforacion fue realizada sobre roca intrusiva la que por su composicion mineralogica se define como granodiorita.

5.5 El registro litologico indica material aluvial hasta los 3.00 m y de 3.00 a 101.27 m se tiene granodiorita color grisacea y textura faneritica.

5.6 La columna de core presenta mucho fracturamiento angular de 3.00 a 90.00 m. y en menor escala de 90.00 a 91.34 m. En el tramo 93.42 a 98.25 m la roca se encuentra muy fracturada. De los 100.00 a 101.27 m hay poco fracturamiento Hay pequenas fallas a los 95.00, 97.00 y 98.00 m vetillas de cuarzo y calcita a los 97.90 y 98.10 m.

5.7 Existe alteracion hidrotermal y oxidos de fierro en forma alterna en el tramo de 3.00 a 90.00 m.

5.8 Hay presencia de agua en los primeros 3.00 m de material aluvial y en la roca hasta los 40.00 m debido a la filtracion por fracturamiento.

5.9 La calidad de la roca es moderada por su fracturamiento persistente en la columna litologica.

5.10. El pozo FB-1-IGP por su ubicacion en la margen lateral de un deposito (cono) de huayco reciente y al pie de una elevacion rocosa con pendiente (60 grados), esta expuesto a riesgo geologico por huaycos y caida de bloques desde las cumbres. Estos fenomenos se evidenciaron durante la lluvia torrencial ocurrida el 22.12.86. Por lo que es recomendable construir una muralla de proteccion para bloquear el acceso de material aluvional hacia el pozo. De otro lado, es necesario que la caseta sea construida en base a un diseno especial de estructura que incluya techo con pendiente similar al talud del cerro vecino, a fin de que cuando se produzca caida de bloques estos resbalen por el techo sin producir impacto.

Tambien, es necesario buena cimentacion, paredes

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resistentes y senalizacion apropiada, pues como sabemos, el pozo esta al mismo nivel de la carretera a Ticrapo.

INSTITUTO GEOFISICO DEL PERU — DPTO DE GEOFISICA APLICADA

^210 REGISTRO DE PERFORACION

SONDAJE: PB-2-IGP
ELEVACION:
COORDENADAS:
LATITUD: 19° 29' 27" S
LONGITUD: 75° 28' 31" W
INCLINACION: 90°
DIAMETRO: 3.56"

Granodiorita
Diaclasam.
Fracturam.
Falla

PROYECTO: 101010-AID/CIW-IGP
PERFORADO POR: GEOTEC SA
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA: 101.27
FECHA INICIAL: 20.12.86
FECHA FINAL: 29.12.86
ESCALA VENTICAL: 1/12.5

FECHA	PROF Y ORCSOR	MUES-TRA	RECU PERA CION	CARACTERISTICAS CO-LOR	INT EMP	FRA CTU	DIA CLA	F A	DESCRIPCION LITOLOGICA	SIMBO LOGIA	OBSERVACION
	100.00										
	100.22								granodiorita con poco fractu-ramiento angular pero		
	100.68										
	100.79										
	101.00								Vetilla de mineral rosado (covider). rellenando fractura.		
	101.02										
	101.27										

F.M. / J.C.G.A. REALIZADO POR: FELIX MONGE C. FECHA:

INSTITUTO GEOFISICO DEL PERU — DPTO DE GEOFISICA APLICADA

^210 REGISTRO DE PERFORACION

SONDAJE: PB-1-IGP
ELEVACION:
COORDENADAS:
LATITUD: 13°29'27"S
LONGITUD: 75°28'31"W
INCLINACION: 90°
DIAMETRO: 3.56"

Granodiorita
Diaclasam.
Fracturam.
Falla

PROYECTO: 101010-AID/CIW-IGP
PERFORADO POR: GEOTEC SA
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA: 101.27
FECHA INICIAL: 20.12.86
FECHA FINAL: 29.12.86
ESCALA VERTICAL: 1/12.5

FECHA	PROF Y GROSOR	MUESTRA	RECUPERACION	CARACTERISTICAS: COLOR	INTEMP	FRACTU	DIACLA	FALLA	DESCRIPCION LITOLOGICA	SIMBOLOGIA	OBSERVACION
	98.00										
	98.09								Vetilla de cuarzo y falla angosta rellenada con calcita y epidota.		
	98.12										
	98.25										
	99.00								Granodiorita Sana y sin estructuras		
									fractura con relleno de mineral rosa (rosid)		
	100.00										

F.M./J.C.G.A. REALIZADO POR: Felix Monge FECHA:

INSTITUTO GEOFISICO DEL PERU — DPTO DE GEOFISICA APLICADA

210 REGISTRO DE PERFORACION

SONDAJE: PB-1-IGP
ELEVACION:
COORDENADAS:
LATITUD: 13° 29' 27" S
LONGITUD: 75° 28' 31" W
INCLINACION: 90°
DIAMETRO: 3.56"

Granodiorita
Diaclasam.
Fracturam.
Falla.

PROYECTO: 101010-ACD/CIW-IGP
PERFORADO POR: GEOTEC SA
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA: 101.27
FECHA INICIAL: 20.12.86
FECHA FINAL: 29.12.86
ESCALA VERTICAL: 1/12.5

FECHA	PROF Y ORGSOR	MUES-TRA	RECU-PERA-CION	CARACTERISTICAS CO-LOR	INT EMP	FRA CTU	DIA CLA	F A	DESCRIPCION LITOLOGICA	SIMBOLOGIA	OBSERVACION
	96.00										
	96.24								Granodiorita con poco fracturamiento.		
	96.42										
	97.00										
	97.09								Granodiorita con mucho fracturamiento subangular		
	97.16										
	97.22										
	97.27										
	97.33										
	97.38										
	97.42										
	97.46										
	97.48										
	97.52										
	97.56										
	97.58										
	97.62										
	97.65										
	97.70										
	97.72										
	97.75										
	97.85								Vetillos de cuarzo		
	98.00										

F. M. / J. C. G. A. — REALIZADO POR: Felix Monge C. FECHA:

INSTITUTO GEOFISICO DEL PERU — DPTO DE GEOFISICA APLICADA

^210 REGISTRO DE PERFORACION

SONDAJE: PB-1-IGP
ELEVACION:
COORDENADAS:
LATITUD: 13° 29' 27" S
LONGITUD: 75° 28' 31" W
INCLINACION: 90°
DIAMETRO: 3 5/8"

Granodiorita
Diaclasam.
Fracturam.
Falla

PROYECTO: 1010.10 - A10/C1W - IGP
PERFORADO POR: GEOTEC SA
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA: 101.27
FECHA INICIAL: 20.12.86
FECHA FINAL: 29.12.86
ESCALA VERTICAL: 1/12.5

FECHA	PROF Y GROSOR	MUESTRA	RECUPERACION	CARACTERISTICAS: CO-LOR	INTEMP	FRACTU	DIACLA	FA	DESCRIPCION LITOLOGICA	SIMBOLOGIA	OBSERVACION
	94.00										
	94.01										
	94.09										
	94.25								Roca grano-diorita con fracturamiento angular		
	94.39										
	94.72										
	94.82										
	95.00										
	95.02								granodiorita con pequeños fallas (delgada) y diaclasamiento angular.		
	95.28										
	95.43										
	95.53										
	95.96										
	96.00										

F. M. / J. C. C. A. — REALIZADO POR: Felix Moncayo C. — FECHA:

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INSTITUTO GEOFISICO DEL PERU — DPTO DE GEOFISICA APLICADA

210 REGISTRO DE PERFORACION

SONDAJE: PB-1-IGP
ELEVACION:
COORDENADAS:
LATITUD: 13° 29' 27" S
LONGITUD: 75° 28' 31" W
INCLINACION: 90°
DIAMETRO: 3.56"

Granodiorita
Diaclasam.
Fracturam.
Falla.

PROYECTO: 101010-ALD/CIW-IGP
PERFORADO POR: GEOTEC S.A.
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA: 101.27
FECHA INICIAL: 20.12.86
FECHA FINAL: 29.12.86
ESCALA VERTICAL: 1/125

FECHA	PROF Y CROSOR	MUES-TRA	RECU-PERA-CION	CARACTERISTICAS CO-LOR	INT EMP	FRA CTU	DIA CLA	F A	DESCRIPCION LITOLOGICA	SIMBO LOGIA	OBSERVACION
	92.00										
									Roca intrusiva Granodiorita estado físico sano y sin alteraciones.		
	93.00										
	93.42								fracturamiento angular		
	93.51										
	93.68										
	93.74										
	93.79										
	93.94										
	94.00										

F. M. / J. C. O. A. — REALIZADO POR: FELIX MONGE C. — FECHA:

INSTITUTO GEOFISICO DEL PERU — DPTO DE GEOFISICA APLICADA

210 REGISTRO DE PERFORACION

SONDAJE: PB-4-IGP
LEVACION:
COORDENADAS:
LATITUD: 13° 22' 27" S
LONGITUD: 75° 28' 31" W
INCLINACION: 90°
DIAMETRO: 3.56"

Granodiorita
Diaclasam.
Fracturam.
Falla

PROYECTO: 101010-AID/CIW-IGP
PERFORADO POR: GEOTEC SA
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA: 101.27
FECHA INICIAL: 20.12.84
FECHA FINAL: 22.12.84
ESCALA VERTICAL: 1/12.5

FECHA	PROF Y OROSOR	MUES-TRA	RECU PERA CION	CARACTERISTICAS CO-LOR	INT EMP	FRA CTU	DIA CLA	F A	DESCRIPCION LITOLOGICA	SIMBO LOGIA	OBSERVACION
	90.00m										
	90.26								Granodiorita con fracturamiento y relleno de mineral rosado (rosicler?)		
	90.35										
	90.63										
	90.73										
	91.00m										
	91.34								"		
	91.36										
	92.00m										

F. M. / J. C. C. A. — REALIZADO POR: Felix Monge C. — FECHA:

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INSTITUTO GEOFISICO DEL PERU — DPTO DE GEOFISICA APLICADA

~210 REGISTRO DE PERFORACION

SONDAJE: PB-4-IGP
ELEVACION:
COORDENADAS:
LATITUD: 13°29'27"S
LONGITUD: 75°29'31"W
INCLINACION: 90°
DIAMETRO: 4 1/2"

Granodiorita
Diaclasa
Fractura
Falla

PROYECTO: 101010-AID/CIW-IGP
PERFORADO POR: GEOTEC SA
PROFUNDIDAD PROGRAMADA: 100.00
PROFUNDIDAD PERFORADA: 101.27
FECHA INICIAL: 20.12.86
FECHA FINAL: 29.12.86
ESCALA VERTICAL: 1/100

FECHA	PROF Y ORCSOR	MUES-TRA	RECU PERA CION	CARACTERISTICAS CO-LOR	INT EMP	FRA CTU	DIA CLA	F A	DESCRIPCION LITOLOGICA	SIMBO LOGIA	OBSERVACION
	0.00 m								Material aluvional		
			70%								
	3.00										
	4.00								Roca intrusiva Granodiorita. Muestra triturada y en polvo de sílice.		
	5.00			blanco amarillento	X	X					
	6.00										
	7.00										
	8.00										
			0%								
	85.00										
	86.00			"	X	X					
	87.00										
	88.00										
	89.00										
	90.00										

F. M. / J. C. O. A. — REALIZADO POR: Felix Monge C. — FECHA:

A N E X O - C

APPENDIX C

LISTA DE PERSONAL DE LA DIRECCION DE FISICA DE LA TIERRA SOLIDA
LIST OF THE PERSONNEL OF THE SOLID EARTH PHYSICS
PARTICIPANTES EN EL PROYECTO RED SISMICA AID/CIW-IGP
DEPARTMENT PARTICIPATING IN THE AID/CIW-IGP SEISMIC NETWORK PROJECT

	SCIENTIFIC INVESTIGATORS: Investigadores Científicos:	US$	TIME TIEMPO %	YEARS AÑOS	TOTAL US$
	Dr. L. Ocola	3,000	20	JAN En 85-Ag 86	12,000
			60	Set. 86	1,800
			30	Jun-Set 87	2,700
			60	Set-Nov 87	5,400
	Dr. D. Huamán	2,500	100	Set-Dic 86	10,000
2.	Profesionales: PROFESIONALS:				
	Ms. O. Macedo	2,000	20	JAN Ene-Nov 87	4,400
	Lic. R. Lindo	1,500	10	Ene 85-Nov 87	1,650
	Br. A. Garro	1,300	30	"	8,970
	Br. F. Monge	1,200	20	"	5,520
	Sr. W. Lescano	1,200	10	"	2,760
	Sr. M. Morales	108	100	Jul-Ago 85	216
3.	Técnicos: TECHNICIANS:				
	Sr. L. Pardo	800	20	Oct 86-Nov 87	2,240
	Srta. C. Aguero	800	10	Ene 85-Nov 87	1,840
	Sr. O. Ancajima	1,000	30	JAN "	6,900
	Srta. M. Ancaya	900	25	"	5,175
	Srta. C. Martínez	900	25	:	5,175
	Sr. G. Pinedo	800	30	"	5,520
				TOTAL US$	73,296

INSTITUTO GEOFISICO DEL PERU

SECTOR EDUCACION

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Part – II

DIRECCION DE SERVICIOS TECNICOS

(TECHNICAL SERVICES DEPARTMENT)

INSTITUTO GEOFISICO DEL PERU
(GEOPHYSICAL INSTITUTE OF PERU)
Dirección de Servicios Técnicos
(Technical Services Department)

THE MONITORING OF SEISMIC ACTIVITY IN PERU

— Nov. 1987 —

INSTITUTO GEOFISICO DEL PERU
(GEOPHYSICAL INSTITUTE OF PERU)
*Dirección de Servicios Técnicos
(Technical Services Department)

THE MONITORING OF SEISMIC ACTIVITY IN PERU

I. INTRODUCTION

EL INSTITUTO GEOFISICO DEL PERU (IGP) holds the monitoring of seismic activity in the country as one of its principal goals. This presupposes installing and maintaining operative the different permanent, portable, telemetry, accelerometer, and strainmeter stations which form la Red Sísmica National (the National Seismic Network). Many of these stations operate through agreement or are included in IGP's Projects with other national institutions like: ELECTROPERU, CHIRA-PIURA, DEPOL (Organismo de Desarrollo del Proyecto Olmos), UNSA (Universidad San-Agustin de Arequipa), Universidad de Tacna, UNI, etc. or with foreign institutions like AID-CIW, University of San Diego-California, University of Kyoto, etc.

At IGP, it is the responsibility of la Dirección de Servicios Técnicos — DST (the Technical Services Department) to operate these stations, as well as carry out the analysis of the seismograms, to evaluate the preliminary parameters of an earthquake in real time, to adequately dispatch seismic information, in addition to being the depository of the information which must be duly included in the monthly and annual seismic bulletins.

DST*-IGP depends on some forty people among professionals and technicians in geology, physics, statistics, electronics, signal analyst, included in the four divisions of: (1) Geophysical Networks, (2) Electronics Laboratory, (3) Seismological Service (which includes in turn the areas of Seismogram Analysis and Seismic Emergency Service), and (4) Projects and Development; in the care of Tech. Antonio Flores (1) and (2), seismologist Matilde Vásquez (3), and seismologist Leandro Rodríguez (4).

The staff of DST*-IGP obtained its initial professional form at the former Dirección Científica de Sismología (Science Department for Seismology under Dr. Daniel Huaco), la Dirección Científica de Geofísica Aplicada (the Science Deparment for Applied Geophysics under Dr. Leonidas Ocola), and in la Jefatura de Redes Geofísicas (the Division of Geophysical Networks under Tech. Alfredo Bushby and Tech. Ernesto Deza), as well as from the Camacho Computer Center. The Camacho Computer Center is concerned with the maintenance and operation of the PRIME computer as well as the Information support which we the users need in Technical Services, Solid Earth Physics, and in other Scientific Areas of IGP's technical site (in Camacho), as well as in the Administrative Sector of the Institute.

II. THE PERUVIAN SEISMIC NETWORK

The National Seismic Network presently includes:

A) 19 permanent Seismic Stations of the WWSSN type or modified (3) and portable ones charged to other projects belonging to Peruvian Institutions in conjunction with IGP.

B) 9 Operative Telemetry Seismic Stations in the Northern (Chilayo), Central (4), and Southern part of Perú (4).

C) 10 Strainmeter Stations from the AID Project (7) and from the University of Kyoto; of these 5 are operative and the remaining ones must be installed within a short time or be replaced.

D) Some twenty accelerometers which operate under Agreement with IGP, charged to other Projects like: ELECTROPERU, CHIRA-PIURA, etc.

A list of the location of equipment, maps, as well as a report concerning the condition of the equipment from the AID Project is given in Appendix I.

On the other hand, the National Seismic Network has been substantially augmented during the first few years of the current decade by telemetry and strainmeter seismic equipment from the AID-CIW/IGP PROJECT. The telemetry signals from the different seismic stations installed in the Central and Southern part of Perú allow one — after inputing them into the System for Seismic Detection in Real Time (Autoseis) of the PRIME Computer (AID) — to determine the focal parameters of an earthquake in real time and to first notify DEFENSA CIVIL DEL PERU (Civil Defense of Peru) and other national agencies when it is a felt earthquake or of Mb $\geq$ 4, for example, from September 1, 1987 to October 3, 1987, we notified DEFENSA CIVIL (Civil Defense) of fourteen earthquakes of magnitude Mb $\geq$ 4.2, (see map No. 3 in Appendix II).

The epicenters preliminarily calculated are subsequently reprocessed with the greatest amount of information which may come from the Ñaña (WWSSN-IGP), Huancayo, Arequipa (UNSA), or from the temporary stations. The new focal parameters are included in a monthly bulletin which is distributed by IGP to different interested national and foreign institutions, (see Appendix II).

The great number of seismic stations operating in the country has allowed one in turn to improve the monitoring of the national seismic activity as can be appreciated in the following Comparative Table:

Years	No. of Events $Mb \geq 4$	No. of Events/Year $Mb \geq 4$
1900–1962	88	1.4
1963–1983	3018	143
1984–16/11/87	985	246

III. THE DST* PERSONNEL AND THE AID-CIW/IGP PROJECT

The maximum operativeness of the Seismic Stations not only has allowed us to monitor the national seismic activity more efficiently, creating better opportunities for the carrying out of scientific studies and other tasks related to seismology, but it has offered better opportunities for other areas related to: seismometry, geology, physics, statistics, and signal analysis. A list of almost fifty people, who have labored at DST* and the Computer Center in connection with the Seismic Network, financed initially by AID, is given in Appendix III. On the list is included an estimation of the time worked directly or indirectly on the Telemetry and Strainmeter Seismic Network, listing in addition salary totals shown in U.S. dollars. For the year 1988, the DST*-IGP estimated expenses can reach $578,150.

*DST — La Dirección de Servicios Técnicos (the Technical Services Department).

IV. PROBLEM AREAS

The lack of replacement seismic equipment, supplies, scientific and technical journals, vehicles in good condition, as well as the lack of a great number of people qualified for the responsibilities created or to be created in conjunction with the Seismic Network, are the greatest problems which have surfaced at IGP. Therefore since the current year, negotiations at the highest level began in order to successfully obtain a Supplementary Credit on the order of $80,000.=, for operating and maintaining IGP's Seismic Network from the month of July 1987. This Credit, included in a new Investment Project (900020), will be able to assure in part the better functioning of the Network and the manipulating of data. Also we are counting on other Investment Projects which allow us to respond to our commitments in connection with the Seismic Network such as was done for the drilling of the holes for the dilatometers (Project 101010), making acquisitions for carrying out studies concerning the improvement of the Seismic Network (900060), etc.

Some of our stations have been robbed, or destroyed by strong rains, electrical storms, low temperatures, or by terrorist acts; reasons for which our staff and our equipment need even better protection and dedication.

Dr. Manual Chang Ching
Director de Servicios Técnicos
(Director of Technical Services)
INSTITUTO GEOFISICO DEL PERU
(GEOPHYSICAL INSTITUTE OF PERU)

APPENDIX 1

- Technical Report concerning the seismic equipment of the AID-IGP PROJECT's Telemetry Seismic Network and Strainmeter Network.
- Location Tables for the Telemetry Seismic Network of Central and Southern Perú and the Strainmeter Network.
- General map of the Seismic Stations of Perú and the Telemetry Seismic Stations.
- Chronology of the PDR-1 Equipment Installation of the AID-CIW/IGP PROJECT.
- System for Seismic Detection in Real Time, Report from Tech. Edmundo Norabuena.

TECHNICAL REPORT CONCERNING THE SEISMIC EQUIPMENT FOR THE TELEMETRY-SEISMIC NETWORK AND THE STRAINMETER NETWORK OF THE AID PROJECT

The following is the equipment received by La Dirección de Servicios Técnicos (the Technical Services Department):

- 5 PDR-1	s/n
	342
	343
	344
	345
	346
- 1 DSP-1	s/n
	142
- 2 TDC-2	s/n
	103
	128
- 3 SS-1	s/n
- 5 Solar Cells	

whose operative state is the following:

PDR-1 EQUIPMENT

s/n 342:

- Electronic-mechanical functioning OK.

- It does not have PRE-AMP boards.

- Recording and copying tests were not conducted for lack of cassettes and playback.

s/n 343:

- It is operative and in good condition for being installed, pertinent tests were conducted.

s/n 344:

- This piece of equipment is in good condition and operating.

- It is installed at NNA.

s/n 345:

- Electronic-mechanical functioning OK.

- Recording and copying tests were not conducted for lack of cassettes and playback.

s/n 346:

- This piece of equipment has no main electronic circuit board.

- Without relay (Ki).

- Without belts on the recording unit.

- This piece of equipment was stolen during the last CIW field trip. Recovered subsequently, substantially damaged.

Piece of equipment DSP-1 s/n 142

- It has inscription problems, one has not finished repairing it for lack of components, it is in repair.

Equipment TDC-2

s/n 103:

- Inoperative, display doesn't illuminate.

s/n 128:

- Inoperative, display doesn't illuminate.

Seismometers Ranger SS-1 (3)

- These seismometers were delivered to Dr. Selwyn Sacks. The serial numbers are unrecognizable. It is necessary for DCFTS to let us know the respective serial numbers in order to be able to identify them.

Solar Cells

- One is at GUA.
- One is at PAR.
- One is at OUI.
- 2 as yet uninstalled.

Sincerely,
Ing. Antonio Flores
Division Head, Networks and
Electronic Lab.
Technical Services Department

Tech. Rider Navarro

Camacho, October 27, 1987

TELEMETRY SEISMIC NETWORK OF THE CENTER(AID EQUIPMENT)
RED SISMICA TELEMETRICA DEL CENTRO (EQUIPOS AID)

ICP

CODE1 CODIGO 1	CODE 2 CODIGO 2	NAME NOMBRE	LATITUD (°S)	LONGITUD(°W)	ELEVACION (m.s.n.m.)	DATE FECHA START/END Inicio/Cierre	FUNDACION GEOLOGICA	OPERATIVENESS OPERATIVIDAD
SAL		SALINAS	11.236	77.611	282	1982/sigue CONTINUES	Volcánico-Sedimentario-Cretaceo	Operativo
SCH	PT08	SUCHE	11.960	76.549	2880	1982/sigue	Volc. Terciario	Operativo
SFE	PT09	SANTA FE	11.677	76.193	5200	1982/sigue	Volc.-Terc.	Operativo
JUN	PT11	JUNI	11.549	75.754	4480	1982/sigue	Arenisca-Cret.	Operativo
COS		COSMOS	12.153	75.560	4525	1982/	Arenisca-Cret.	Inoperativo
ANC		ANGONA	10.851	75.957	4800	1982/	Caliza-Triásica.	Inoperativo
PAJ		PAJONAL	10.639	75.288	2800	1982/		Inoperativo

TELEMETRY SEISMIC NETWORK OF THE SOUTH (AID EQUIPMENT)
RED SISMICA TELEMETRICA DEL SUR (EQUIPOS AID)

IGP

CODIGO 1 CODE 1	CODIGO 2 CODE 2	NOMBRE NAME	LATITUD (°S)	LONGITUD (°W)	ELEVACION (m.s.n.m.)	FECHA (DATE) (START / END) Inicio/Cierre	FUNDACION GEOLOGICA	OPERATIVIDAD OPERATIVENESS
MSR	PT01	MORRO SOLAR	12.181	77.031	278	Oct 78/sigue (CONTINUES)	Roca Sediment.	Operativo
	PT07	ISLAS HORMIGAS	12.054	77.737	33	1980/Dic 81	Roca Metamórf.	Inoperativo
	PT02	QUILMANA	12.943	76.437	510	Jun 77/sigue	Pleistocénica	Operativo
PAR	PT06	PARACAS	13.829	76.331	220	Jun 77/sigue	Diorite	Operativo
GUA	PT03	GUADALUPE	13.992	75.783	550	Dic 77/sigue	Roca Volcánica	Operativo
ZAM	PT04	ZAMACA	14.6722	75.6123	340	Jun 77/Mar 82	Roca Metamórf.	Inoperativo

EXTENSOMETER NETWORK: STATIONS FOR CRUSTAL MOTION (AID)
RED EXTENSOMETRICA ESTACIONES DEL MOVIMIENTO CORTICALES (AID)

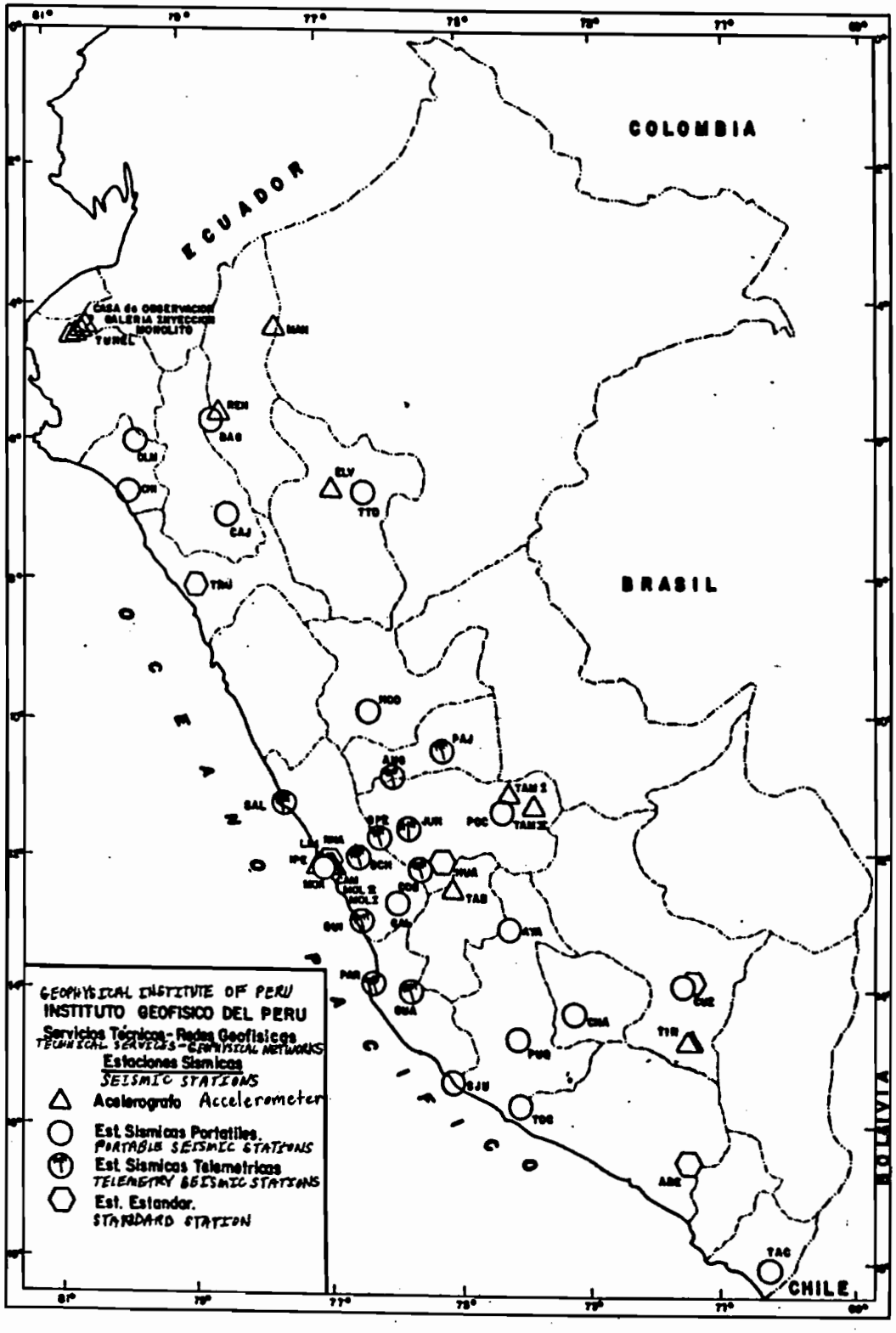
IGP

CODIGO 1 CODE 1	CODIGO 2 CODE 2	NOMBRE NAME	LATITUD (°S)	LONGITUD (°W)	ELEVACION (m.s.n.m.)	FECHA (DATE) START/END Inicio/cierre	FUNDACION GEOLOGICA	OPERATIVIDAD OPERATIVENESS
NNA	NNA	ÑAÑA	11.9875	76.8422	575	1986/sigue CONTINUES	Gabbro	Operativo
QUI	PTO2	QUILMANA	12.943	76.437	510	1986/sigue	Pleistocénica Volcánica	Operativo
PAR	PTO6	PARACAS	13.829	76.331	220	1986/sigue	Diorita	Operativo
GUA	PTO3	GUADALUPE	13.992	75.783	550	1986/sigue	Roca Volcánica.	Operativo
		PAMPA BLANCA	13°29'27"	75°28'31"	1525		Granodiorítica.	Por instalar
		LACHAY	11°21'27"	77°23'13"	Ø.175		Cuarzogranito.	Por instalar
		SONGOS	11°52'50"	76°28'40"	1800		Granodiorítica.	Por instalar.

EXTENSOMETER NETWORK

RED EXTENSOMETRICA

COD. 1 CODE 1	COD. 2 CODE 2	NOMBRE/ESTAC. NAME/STATION	LATITUD (°S)	LONGITUD (°W)	ELEV. m.s.n.m.	DATE FECHA Inic/Cierre START/END	FUNDACION GEOLOGICA	OPERATIVIDAD OPERATIVENESS
CND	PP03	Cóndor	13°32.47'	75°31.45'	1400			Operativo
GUA	PT03	Guadalupe	13.992	75.783	550	Dic 78/sigue	Roca volcánica	Operativo
		Lachay	11°21'27"	77°23'13"	175		Cuarzo granito	Por instalar
NNA	NNA	Ñaña	11.9875	76.8422	575	1986/sigue	Gabbro	Operativo
		Pampa Blanca	13°29'27"	75°28'31"	1525		Granodiorítica	Por instalar
PAR	PT06	Paracas	13.829	76.331	220	1986/sigue	Diorita	Operativo
QUI	PT02	Quilmana	12.943	76.437	510	1986/sigue	Volcánica	Operativo
		Songos	11°52'50"	76°28'40"	1800		Granodiorítica	Por instalar
	PT04	Zamaca	14.6722	75.6123	340	Jun 77/Mar 82	Roca metamórfica	Inoperativa
SRA	PP04	Zaramarca	14°29.13'	75°05.49'	750			Destruida



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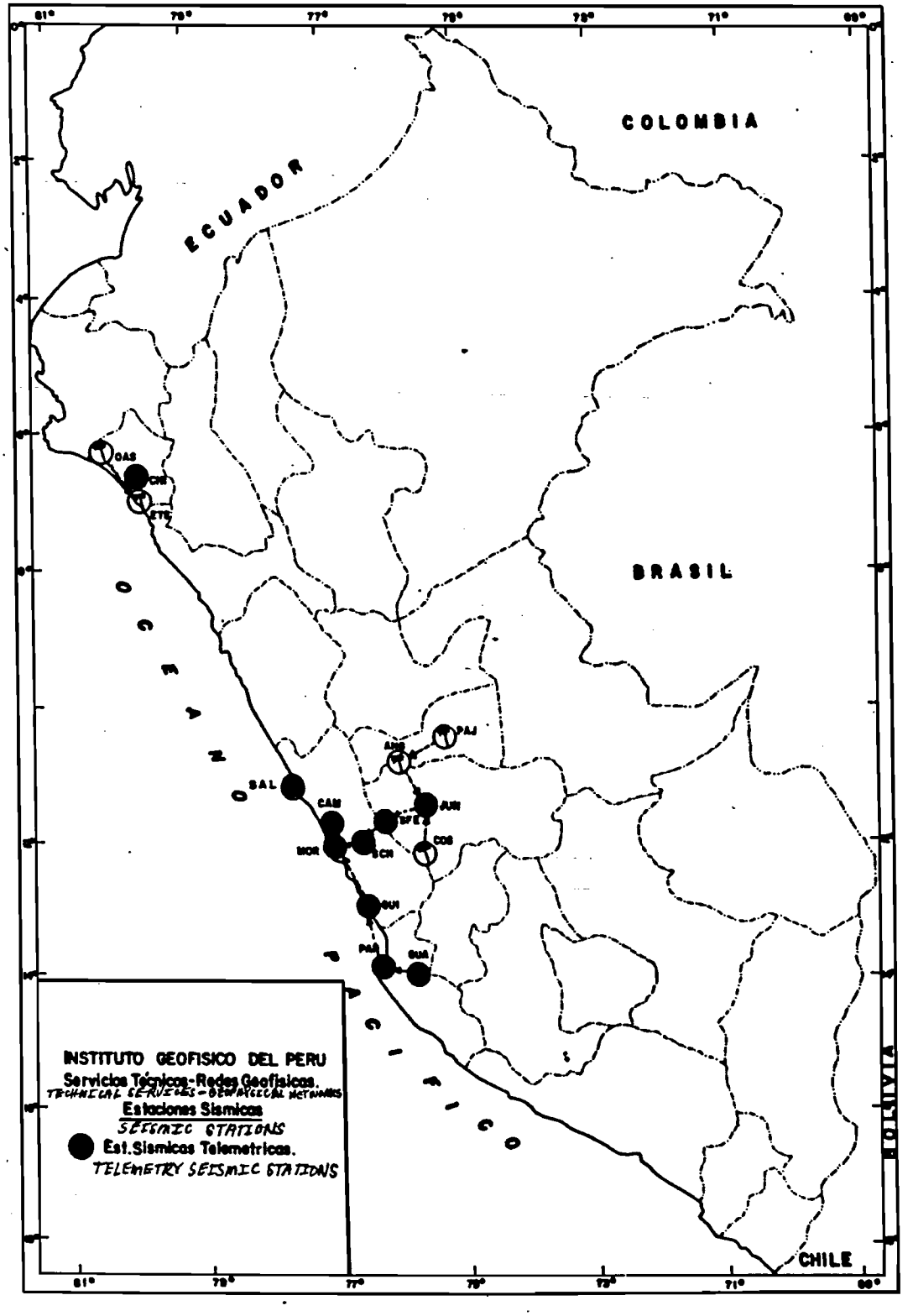

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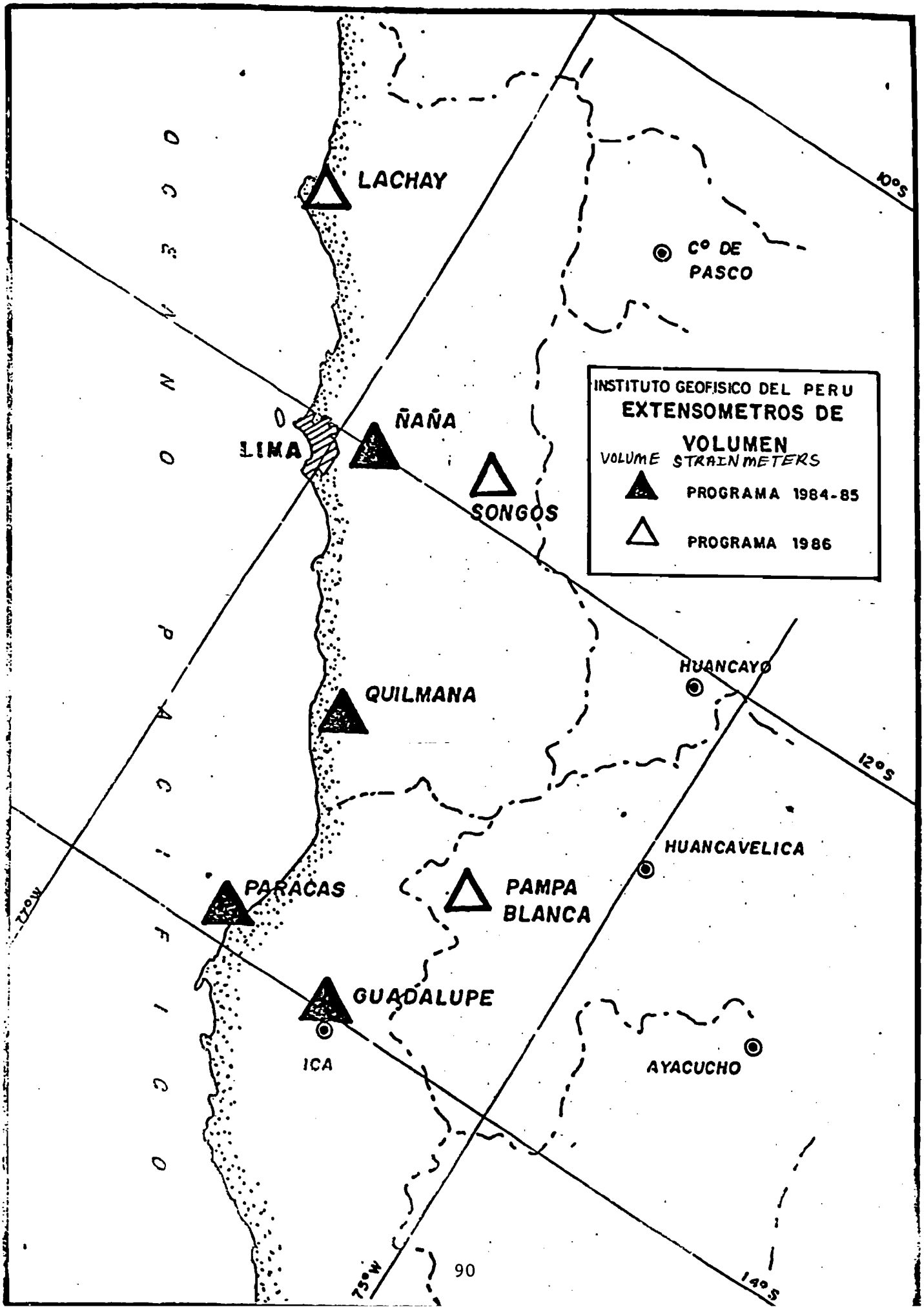

INSTITUTO GEOFISICO DEL PERU
EXTENSOMETROS DE VOLUMEN
VOLUME STRAINMETERS
PROGRAMA 1984-85
PROGRAMA 1986
LACHAY
ÑAÑA
LIMA
SONGOS
QUILMANA
PARACAS
PAMPA BLANCA
GUADALUPE
ICA
Cº DE PASCO
HUANCAYO
HUANCAVELICA
AYACUCHO
OCEANO PACIFICO
10°S
12°S
14°S
77°W
75°W

CHRONOLOGY OF THE INSTALLATION OF PDR-1 Y EQUIPMENT
CRONOGRAMA DE INSTALACION DE EQUIPOS PDR-1 Y

REINSTALLATION OF THE ANCON AND PAJONAL STATIONS
REINSTALACION DE LAS ESTACIONES DE ANCON Y PAJONAL

AID-CIW/IGP PROJECT
PROYECTO AID-CIW/IGP

ESTACION STATION	1986 Nov.	Dic.	1987 Ene.	Feb.	Mar.	Abr.	May.	Jun.	Jul.
Guadalupe	========								
Quilmana		==========							
Paracas		==========							
Angora					==========				
Pajonal					==========				

System for Seismic Detection in Real Time

1. The System for Seismic Detection and Processing in real time consists of the following resources:

    1.1 A main computer, PRIME model 250–11, with one megabyte of physical memory.

    1.2 A 300 megabyte disk unit for secondary storage (contributed by IGP).

    1.3 Two magnetic tape units, Kennedy model 9100 (1600/800 bpi, 45 ips).

    1.4 Two Pertec tape units (Inoperative).

    1.5 A printer, Printronix model 300 LPM.

    1.6 A seismic signal pre-processor.

    1.7 Two video terminals, PRIME PT25.

    1.8 A Tektronix 4010 graphics terminal.

    1.9 Two Heathkit H89 micro-computers connected to the host. (IGP's contribution)

    1.10 A video terminal, VT-240.

    1.11 An LA-50 printer.

    1.12 A Kinemetrics digital playback unit, model DSP-3, connected to the host. (IGP's contribution)

    1.13 A 64 Mbytes CMD disk unit (inoperative).

As for the service lines the 250-II system is presently saturated.

2. Computer System, PRIME model 2655

This new system would replace the former one. This would improve the performance of the system for real time seismic data acquisition and processing. The system, which has been received from Carnegie Institution of Washington, as part of the AID/CIW/IGP PROJECT, is a basic system consisting of:

2.1 Central Processor 2655 with four (4) megabytes of physical memory.

2.2 A 496 megabyte disk unit, including controller.

IGP has acquired a controller which would allow one access to this system with 16 asynchronous lines. The new system would allow one to possibly incorporate one of the Pertec tape units which to date is inoperative.

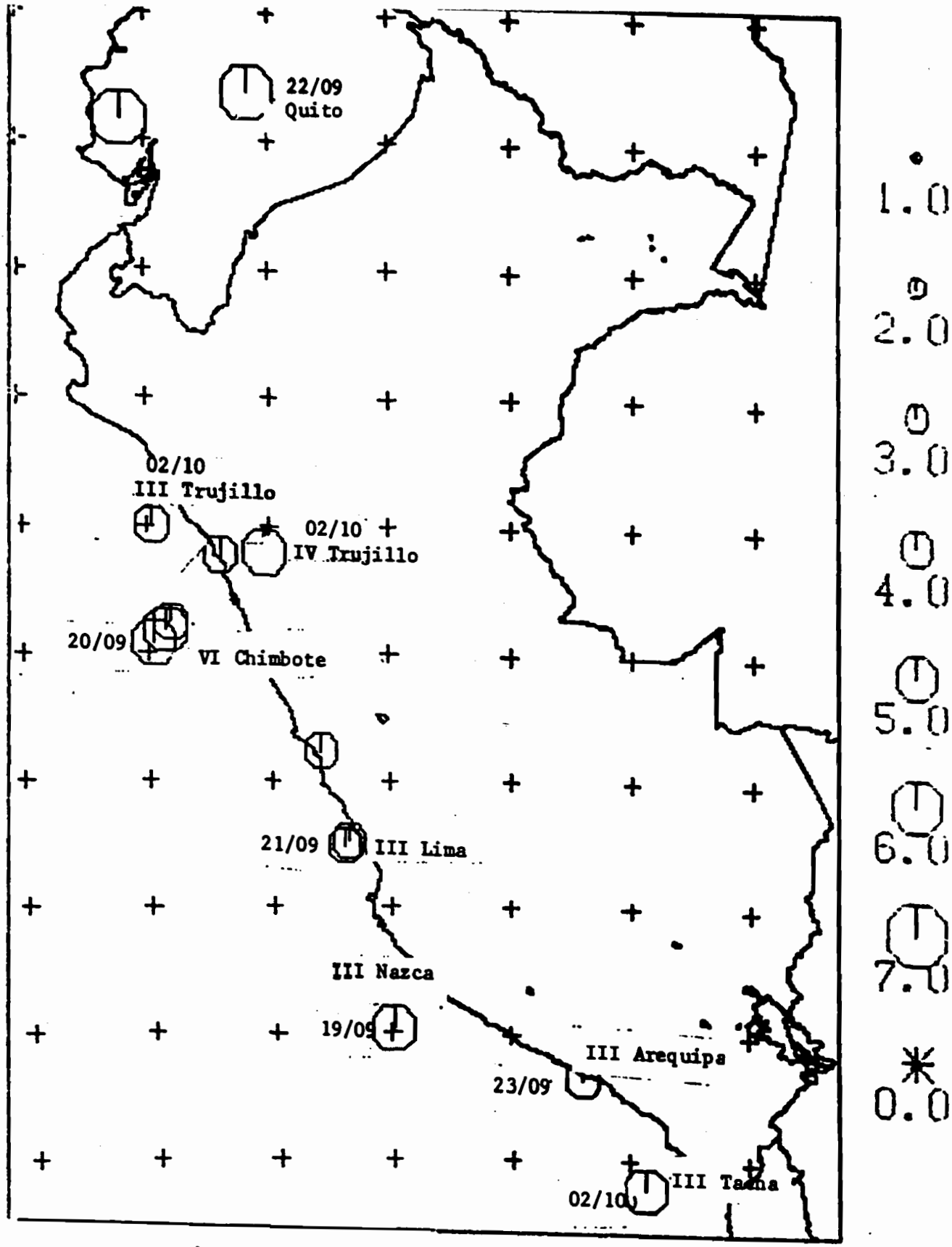
The result of integrating both systems would enormously elevate the performance of the system for real time data acquisition and processing, whilst permitting its parallel usage in interactive processes connected with seismological studies and related geophysical applications. The basic possibilities for expansion consist in the total use of the asynchronous lines which would allow one to connect additional resources such as: digitizers, plotters, graphics terminals, digital playback systems, and workstations based on IBM PC's.

Monterrico, October 28, 1987.

E. Norabuena

APPENDIX 2

- Map of the distribution of Earthquakes of Mb $\geq$ 4.2 reported to DEFENSA CIVIL DEL PERU (Civil Defense of Perú) between Sept. 1, 1987 and Oct. 3, 1987, 14 earthquakes.
- List of Institutions to which IGP sends Monthly Seismic Bulletins.
- Sample Preliminary Seismic Bulletin No. 084 – Sept. 1986.
- Autoseis Seismic Signals for the earthquakes on November 3 and 4, 1987.
- Copy of Seismograms from Quilmaná Station – Main Event and Aftershock of 15/06/87.



earthquakes of magnitude - 4.2
SISMOS DE MAGNITUD _ 4.2

Meses de Setiembre y Octubre 1987
Months of

1° Setiembre al 3 de Octubre

14 Sismos (earthquakes)

LIST OF INSTITUTIONS TO WHICH
LISTA DE INSTITUCIONES A LAS CUALES

IGP SENDS MONTHLY SEISMIC BULLETINS
EL IGP REMITE BOLETINES SISMICOS MENSUALES

1. CENTRO REGIONAL DE SISMOLOGIA PARA AMERICA DEL SUR - CERESIS
2. Dr. SACKS -CIW, -AID-USA
3. INSTITUTO NACIONAL DE ESTADISTICA DEL PERU - INE
4. SISTEMA NACIONAL DE DEFENSA CIVIL DEL PERU
5. HIDROGRAFIA Y FAROS MARINA DEL PERU
6. CORPORACION PERUANA DE AEROPUERTOS - CORPAC
7. UNIVERSIDAD DE TACNA
8. INSTITUTO GEOFISICO DEL PERU

PRESIDENCIA EJECUTIVA	: Ing. Mateo Casaverde Río
DIRECCION TECNICA	:
DCFTS	: Dr. Leonidas Ocola A.
MOVIMIENTO DE CORTEZA TERRESTRE	: Ing. Ernesto Deza
OBSERVATORIO DE HUANCAYO	: Dr. Mutsumi Ishitsuka

- . -

PRELIMINARY SEISMIC BULLETIN

INSTITUTO GEOFISICO DEL PERU

SECTOR EDUCACION

SERVICIO SISMOLOGICO

BOLETIN SISMICO

PRELIMINAR

NO. 084

SETIEMBRE 1986

SERVICIOS TECNICOS
CENTRO DE PROCESAMIENTO SISMICO

BOLETIN SISMICO PRELIMINAR
(PRELIMINARY SEISMIC BULLETIN)

El Boletin Sísmico Preliminar (BSP) — The Preliminary Seismic Bulletin, is a publication of el Instituto Geofísico del Perú (the Geophysical Institute of Perú), aimed at furnishing information about the seismic activity which occurs in the country.

It contains the hypocenters calculated by the program "FASTHYPO" with a velocity/depth distribution model derived from the inversion of the distance curve — the time is obtained from the records of shallow earthquakes recorded at the seismic stations which operate in Perú.

In the determination of the focal coordinates of the BSP remote stations with a telemetry link to the Center for Seismic Processing in Real Time are generally used. Therefore the time control is precise, and in some cases stations belonging to the worldwide network are added: Nana (NNA), Huancayo (HUA), and Arequipa (ARE). The epicenter coordinates are expressed in degrees and the error in degrees and km. The depth is given in km and in cases where the error is 0.00 km, it means that the program has not resolved the depth and the depth must be considered a constrained value and therefore not reliable.

The magnitude mb is calculated using the NNA Station according to the formula: mb = log (A/T) + Q, where A is the amplitude of the P wave in microns, T the period, and Q is the distance-depth factor. This relation is utilized for all the earthquakes where it was possible to read the amplitude and the period of the P wave on the vertical short period (SPZ) seismograms, even for earthquakes where the mb is not defined, that is, with a distance to the hypocenter less than 555 km.

In some cases the magnitude given by the National Earthquake Information Service (NEIS) has been given.

The Intensity is measured according to Modified Mercalli (MM) scale.

The focal coordinates are preliminary. Their final value will be calculated, using the complete national network, and published in el Boletin Sísmico de Perú (the Seismic Bulletin of Perú).

SEISMIC STATIONS OF PERU

ESTACIONES SISMICAS DEL PERU

INSTITUTO GEOFISICO DEL PERU

Nro.	Cod. 1	Cod. 2	NombreEstacion	Latitud(S)	Longitud(W)	Elevacion(M
1	ANQ		ANGONA	10.851	75.957	4800
2	ARE	ARE	AREQUIPA	16.462	71.491	2451
3	BAQ		BAQUA	05.646	78.584	530
4	CAJ		CAJAMARCA	07.080	78.390	2676
5	CAL	PP02	CALACHOTA	12.627	75.978	1655
6	CAM	PT10	CAMACHO	12.075	76.969	274
7	COS		COSMOS	12.153	75.560	4525
8	CHA	PP08	CHALHUANCA	14.268	73.245	3000
9	CHI	CHPB	CHICLAYO	06.765	79.865	60
10	CUZ		CUZCO	13.563	71.877	3240
11	ETE	CHP7	ETEN	06.940	79.855	200
12	GUA	PT03	GUADALUPE	13.992	75.783	550
13	HUA	HUA	HUANCAYO	12.038	75.323	3313
14	HCO		HUANUCO	09.830	76.230	1851
15	ILL	CHP9	ILLESCAS	06.025	80.945	380
16	JUN	PT11	JUNI	11.549	75.751	4480
17	MOR	PT01	MORRO SOLAR	12.181	77.031	278
18	MOY	PP11	MOYA	13.025	74 138	3300
19	NNA	NNA	NANA	11.987	76.842	575
20	OAS		OASIS	06.336	80.375	40
21	OLM		OLMOS	05.970	79.710	150
22	PAJ		PAJONAL	10.639	75.268	2800
23	PAR	PT06	PARACAS	13.829	76.331	220
24	POC		PTO. OCOPA	11.250	74.330	750
25	PUQ	PP06	PUQUIO	14.696	74.124	3200
26	QUI	PT02	QUILMANA	12.943	76.437	510
27	SAL		PTA. SALINAS	11.236	77.611	282
28	SJU	PP09	SAN JUAN	15.356	75.179	75
29	SFE	PT09	SANTA FE	11.677	76.193	5200
30	SCH	PT08	SUCHE	11.960	76.549	2880
31	TAC		TACNA	18.010	70.260	560
32	TTO		TARAPOTO	06.580	76.380	356
33	TOC	PP05	TOCOTA	15.656	74 087	1005

Servicios Tecnicos
1986

```
1·PICENTRO NO.        1
     PERU,02 SET 1986
     HORA:            1H46M 55.18S   GMI
     LATITUD:       12.4775+-      0.02898          3.1945KM
     LONGITUD:      76.7274+-      0.0437W          4.7408KM
     PROFUNDI:        65.13+-        5.43KM
     MAGNITUD:       3.5 Mb
     INTENSID:
      STA    DIST    AZM   AIN   P-SEC   TPCAL   P-RES WT    S-SEC   S-RES WT MAG
      GUI    60.14   328   138    9.5    13.9     0.4  0     18.4    -0.8  0
      MOR    46.43   134   145    8.5    12.5     0.8  0     17.4     0.5  0
      SCH    60.76   199   137    9.9    13.9     0.8  0     19.3    -0.0  0
      SAL   167.62   145   118   22.3    28.3    -1.2  0     44.0    -0.2  0
      NNA    55.60   167   140    9.0    13.4     0.4  0     17.9    -0.9  0 3.5Mb
  RMC=       0.885
1·PICENTRO NO.        2
     PERU,03 SET 1986
     HORA:           12H21M 20.38S   GMI
     LATITUD:       11.1988+-      0.04008          4.4254KM
     LONGITUD:      76.7344+-      0.0401W          4.3741KM
     PROFUNDI:       100.00+-        0.00KM
     MAGNITUD:       3.7 Mb
     INTENSID:
      STA    DIST    AZM   AIN   P-SEC   TPCAL   P-RES WT    S-SEC   S-RES WT MAG
      MOR   113.30    16   114   43.5    24.2    -1.0  0     61.9    -0.3  0
      SCH    86.82   345   114   41.3    20.8     0.1  0     57.1     0.6  0
      SAL    95.62    87   114   42.4    21.9     0.1  0     58.7     0.3  0
      NNA    87.92     7   114   46.0    21.0     4.6  4     56.8     0.1  0 3.7Mb
  RMC=       0.707
1·PICENTRO NO.        3
     PERU,03 SET 1986
     HORA:           21H42M  8.79S   GMI
     LATITUD:       11.8531+-      0.00358          0.3866KM
     LONGITUD:      77.2711+-      0.0034W          0.3662KM
     PROFUNDI:        65.75+-        0.53KM
     MAGNITUD:       3.6 Mb
     INTENSID:
      STA    DIST    AZM   AIN   P-SEC   TPCAL   P-RES WT    S-SEC   S-RES WT MAG
      MOR    44.75   324   146   21.3    12.4     0.1  0     30.3    -0.1  0
      SCH    80.38   278   131   25.0    16.3    -0.1  0     37.0     0.0  0
      SAL    77.65   151   131   24.7    15.9    -0.0  0     36.4    -0.0  0
      NNA    49.27   287   143   21.7    12.9     0.0  0     31.0    -0.1  0 3.6Mb
  RMC=       0.066
1·PICENTRO NO.        4
     PERU,04 SET 1986
     HORA:            3H52M 17.93S   GMI
     LATITUD:       12.5959+-      0.0220S          2.4383KM
     LONGITUD:      75.8834+-      0.0615W          7.0024KM
     PROFUNDI:        12.00+-        0.00KM
     MAGNITUD:       3.9 Mb
     INTENSID:
      STA    DIST    AZM   AIN   P-SEC   TPCAL   P-RES WT    S-SEC   S-RES WT MAG
      GUI    70.98    57   114   30.0    12.2    -0.2  0     39.0    -0.1  0
      MOR   132.67   110   114   40.7    22.0     0.8  0      0.0     0.0  0
      SCH   100.17   134   114   34.4    16.8    -0.4  0     46.9    -0.2  0
      NNA   123.72   122   114   43.5    20.6     5.0  4      0.0     0.0  0 3.9Mb
  RMC=       0.712
1·PICENTRO NO.        5
     PERU,03 SET 1986
     HORA:           12H21M 20.38S   GMI
     LATITUD:       11.1988+-      0.0400S          4.4254KM
     LONGITUD:      76.7344+-      0.0401W          4.3741KM
     PROFUNDI:       100.00+-        0.00KM
     MAGNITUD:       3.7 Mb
     INTENSID:
      STA    DIST    AZM   AIN   P-SEC   TPCAL   P-RES WT    S-SEC   S-RES WT MAG
      MOR   113.30    16   114   43.5    24.2    -1.0  0     61.9    -0.3  0
      SCH    86.82   345   114   41.3    20.8     0.1  0     57.1     0.6  0
      SAL    95.62    87   114   42.4    21.9     0.1  0     58.7     0.3  0
      NNA    87.92     7   114   46.0    21.0     4.6  4     56.8     0.1  0 3.7Mb
  RMC=       0.707
```

PICENTRO NO. 6
PERU, 07 SET 1986
HORA: 1H41M 30.90S GMI
LATITUD: 11.6641+- 0.01408 1.5484KM
LONGITUD: 77.4140+- 0.0164W 1.7900KM
PROFUNDI: 55.91+- 2.79KM
MAGNITUD:
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
MOR	70.81	323	130	44.9	14.1	-0.1	0	55.4	0.0	0	
SCH	100.55	288	123	48.8	18.0	-0.1	0	62.2	0.0	0	
SAL	51.99	155	137	43.1	11.9	0.3	0	51.4	-0.2	0	

RMC= 0.264

PICENTRO NO. 7
PERU, 07 SET 1986
HORA: 4H51M 36.51S GMI
LATITUD: 11.7021+- 0.00318 0.3400KM
LONGITUD: 77.3169+- 0.0032W 0.3504KM
PROFUNDI: 55.67+- 0.56KM
MAGNITUD: 3.2 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
ARE	819.87	309	50	12.0	116.8	=141.	4	0.0	0.0	0	
MOR	61.48	329	133	49.4	13.0	-0.1	0	59.0	0.0	0	
SCH	89.19	288	125	53.0	16.5	0.0	0	65.0	-0.1	0	
SAL	60.70	148	133	49.4	12.9	0.0	0	58.8	-0.0	0	
NNA	60.79	301	133	49.5	12.9	0.1	0	58.8	-0.0	0	3.2Mb

RMC= 0.065

PICENTRO NO. 8
PERU, 07 SET 1986
HORA: 7H37M 15.16S GMI
LATITUD: 15.9153+- 0.06158 7.1357KM
LONGITUD: 75.0853+- 0.1359W 14.5428KM
PROFUNDI: 15.42+- 7.44KM
MAGNITUD: 4.9 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
GUI	359.90	156	114	14.0	57.8	1.0	0	0.0	0.0	0	
MOR	463.37	153	114	28.9	74.1	-0.4	0	0.0	0.0	0	
SCH	464.91	160	114	28.1	74.4	-1.4	0	83.5	-0.5	0	
SAL	585.26	152	50	45.5	91.3	-1.0	0	113.7	0.4	0	
HUA	429.73	176	114	24.7	68.8	0.7	0	74.0	-0.4	0	
NNA	474.04	156	114	32.0	75.8	1.0	0	0.0	0.0	0	4.9Mb

RMC= 1.119

PICENTRO NO. 9
PERU, 07 SET 1986
HORA: 18H19M 38.94S GMI
LATITUD: 12.0090+- 0.02468 2.7171KM
LONGITUD: 77.1416+- 0.0283W 3.0756KM
PROFUNDI: 65.98+- 3.92KM
MAGNITUD: 3.3 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
GUI	128.35	323	122	0.0	22.7	0.0	0	77.5	-0.7	0	
MOR	22.57	327	161	50.0	10.9	0.1	0	58.1	0.3	0	
SCH	65.63	265	136	54.1	14.6	0.6	0	63.7	-0.5	0	
SAL	99.61	149	126	57.6	18.7	-0.1	0	70.9	-0.5	0	
NNA	32.99	265	153	51.3	11.5	0.8	0	58.8	-0.1	0	3.3Mb

RMC= 0.631

PICENTRO NO. 10
PERU, 11 SET 1986
HORA: 23H30M 18.87S GMI
LATITUD: 13.3408+- 0.03058 3.3762KM
LONGITUD: 74.2104+- 0.0329W 3.5615KM
PROFUNDI: 15.00+- 0.00KM
MAGNITUD: 4.7 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
GUI	245.00	100	114	59.2	39.7	0.6	0	86.1	-1.5	0	
PAR	238.60	75	114	58.6	38.7	1.1	0	85.8	-0.1	0	
JUN	256.84	140	114	60.7	41.5	0.3	0	90.8	-0.0	0	
SFE	283.14	130	114	66.6	45.7	2.0	0	0.0	0.0	0	
ARE	452.43	319	114	90.5	72.4	-0.8	0	0.0	0.0	0	
HUA	187.90	140	114	48.5	30.7	-1.1	0	71.5	-0.5	0	
NNA	322.04	117	114	70.4	51.8	-0.3	0	108.5	-0.2	0	4.7Mb

RMC= 1.103

I·PICENTRO NO. 11
PERU, 12 SET 1986
HORA: 9H26M 40.89S GMI
LATITUD: 13.1508+- 0.02698 2.9730KM
LONGITUD: 76.3889+- 0.0422W 4.5659KM
PROFUNDI: 68.17+- 6.03KM
MAGNITUD: 3.8 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
GUI	23.87	167	161	52.7	11.3	0.5	0	60.5	0.0	0	
PAR	80.46	356	132	57.7	16.5	0.3	0	68.9	-0.6	0	
MOR	127.85	147	122	64.0	22.8	0.3	0	0.0	0.0	0	
SFE	164.42	187	119	69.4	28.0	0.5	0	0.0	0.0	0	
SAL	249.99	147	116	79.8	40.8	-1.9	0	0.0	0.0	0	
HUA	168.97	223	119	69.7	28.7	0.1	0	89.9	-0.6	0	
NNA	137.70	159	121	67.0	24.1	2.0	0	82.0	-0.7	0	3.8M

RMC= 1.163

I·PICENTRO NO. 12
PERU, 12 SET 1986
HORA: 13H21M 16.55S GMI
LATITUD: 8.4121+- 0.07608 8.4012KM
LONGITUD: 75.8901+- 0.0780W 8.5621KM
PROFUNDI: 68.60+- 3.86KM
MAGNITUD: 4.1 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
GUI	504.38	6	50	31.5	76.1	-1.1	0	87.9	-0.4	0	
MOR	435.10	16	50	23.2	67.4	-0.8	0	73.8	0.5	0	
SFE	362.65	5	115	15.4	58.2	0.6	0	0.0	0.0	0	
JUN	347.50	356	115	12.3	55.9	-0.1	0	0.0	0.0	0	
SAL	364.73	31	115	15.3	58.6	0.2	0	57.5	-0.5	0	
NNA	408.80	14	50	22.0	64.1	1.3	0	61.0	-6.6	4	4.1M

RMC= 0.929

I·PICENTRO NO. 13
PERU, 12 SET 1986
HORA: 17H34M 43.38S GMI
LATITUD: 16.4106+- 0.11598 12.8277KM
LONGITUD: 73.7385+- 0.0733W 7.8181KM
PROFUNDI: 100.00+- 0.00KM
MAGNITUD: 4.3 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	396.41	135	114	38.9	59.6	-4.1	4	84.8	-1.8	0	
MOR	587.20	142	114	61.1	83.5	-5.7	4	0.0	0.0	0	
SFE	586.85	153	114	67.2	83.4	0.4	0	0.0	0.0	0	
SAL	708.93	143	114	75.2	98.7	-6.9	4	0.0	0.0	0	
ARE	239.89	271	114	24.6	40.0	1.2	0	51.0	-1.7	0	
HUA	513.01	160	114	58.7	74.2	1.1	0	112.5	0.6	0	
NNA	592.68	145	114	68.0	84.1	0.5	0	128.2	-0.9	0	4.3M

RMC= 1.375

I·PICENTRO NO. 14
PERU, 13 SET 1986
HORA: 9H47M 30.49S GMI
LATITUD: 13.5330+- 0.02228 2.4614KM
LONGITUD: 77.0547+- 0.0303W 3.2728KM
PROFUNDI: 13.00+- 0.00KM
MAGNITUD: 3.5 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	85.21	296	114	44.9	14.5	-0.1	0	55.1	-0.5	0	
GUI	93.75	225	114	46.4	15.8	0.1	0	57.0	-0.9	0	
MOR	149.60	181	114	56.0	24.6	0.9	0	0.0	0.0	0	
SCH	182.75	197	114	59.9	29.9	-0.5	0	80.7	-1.5	0	
SFE	225.61	204	114	66.7	36.6	-0.4	0	94.7	0.8	0	
SAL	261.19	166	114	72.4	42.2	-0.3	0	0.0	0.0	0	
HUA	250.28	228	114	72.2	40.5	1.2	0	101.5	0.8	0	
NNA	172.63	187	114	58.8	28.3	0.0	0	75.6	-3.8	4	3.5M

RMC= 0.888

PICENTRO NO. 15
PERU, 13 SET 1986
HORA: 22H 8M 57.64S OMI
LATITUD: 12.6931+- 0.01248 1.3694KM
LONGITUD: 76.8169+- 0.0277W 3.0011KM
PROFUNDI: 50.18+- 4.61KM
MAGNITUD: 3.4 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
GUI	49.51	303	136	9.5	11.0	0.8	0	17.2	0.5	0	
MOR	61.19	157	130	10.5	12.4	0.5	0	18.8	-0.3	0	
SCH	86.49	200	123	13.3	15.7	-0.0	0	24.1	-0.7	0	
SFE	131.26	211	118	20.2	22.1	0.5	0	35.6	-0.3	0	
PAR	140.43	338	118	21.6	23.5	0.5	0	36.8	-1.5	0	
SAL	182.85	151	116	24.6	29.9	-2.9	4	0.0	0.0	0	
HUA	177.75	245	116	48.9	29.1	22.2	4	0.0	0.0	0	
NNA	78.15	178	125	12.0	14.5	-0.2	0	21.7	-1.1	4	3.4Mb

RMC= 0.738

PICENTRO NO. 16
PERU, 15 SET 1986
HORA: 6H 5M 37.52S OMI
LATITUD: 12.3730+- 0.0377S 4.1666KM
LONGITUD: 77.0356+- 0.0380W 4.1305KM
PROFUNDI: 57.67+- 6.43KM
MAGNITUD: 4.4 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
GUI	90.36	313	125	53.9	16.8	-0.4	0	64.6	-2.0	0	
MOR	21.25	181	160	48.5	9.6	1.4	0	55.1	0.9	0	
SCH	70.62	229	130	52.3	14.3	0.5	0	61.3	-0.9	0	
SFE	119.66	229	121	59.1	20.9	0.7	0	72.1	-1.6	0	
SAL	140.49	153	119	61.0	23.9	-0.4	0	76.9	-2.0	0	
HUA	189.81	258	117	70.5	31.2	1.7	0	92.0	0.4	0	
NNA	47.75	206	140	50.5	11.7	1.3	0	58.0	0.2	0	4.4Mb

RMC= 1.399

PICENTRO NO. 17
PERU, 16 SET 1986
HORA: 4H27M 0.63S OMI
LATITUD: 10.0180+- 0.1401S 15.4982KM
LONGITUD: 78.7442+- 0.2026W 22.1542KM
PROFUNDI: 120.00+- 0.00KM
MAGNITUD: 4.5 Mb
INTENSID: III MM CHIMBOTE, II MM CASMA

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
MOR	303.61	322	114	49.1	48.1	0.4	0	0.0	0.0	0	
SCH	322.40	311	114	51.3	50.4	0.2	0	0.0	0.0	0	
SFE	333.42	303	114	53.7	51.8	1.3	0	0.0	0.0	0	
JUN	371.45	297	114	57.0	56.5	-0.2	0	0.0	0.0	0	
CHI	380.27	161	114	57.8	57.7	-0.5	0	0.0	0.0	0	
NNA	301.02	316	114	39.0	47.7	-9.4	4	82.0	-1.3	0	4.5Mb

RMC= 1.187

PICENTRO NO. 18
PERU, 16 SET 1986
HORA: 6H11M 49.65S OMI
LATITUD: 13.4362+- 0.0243S 2.6891KM
LONGITUD: 76.9275+- 0.0556W 6.0095KM
PROFUNDI: 20.00+- 46.98KM
MAGNITUD: 3.7 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
GUI	81.46	226	114	3.1	13.1	0.3	0	11.5	-0.9	0	
PAR	83.14	304	114	2.4	13.4	-0.7	0	12.2	-0.7	0	
SCH	171.41	196	114	16.5	27.3	-0.5	0	36.5	-0.5	0	
SFE	213.75	203	114	23.8	34.8	-0.6	0	48.4	-1.4	0	
NNA	162.35	185	114	15.6	25.9	0.0	0	34.0	-0.5	0	3.7Mb

RMC= 0.944

PICENTRO NO. 19
PERU, 16 SET 1986
HORA: 4H28M 44.90S OMI
LATITUD: 9.2594+- 0.1566S 17.3168KM
LONGITUD: 78.4508+- 0.2636W 28.8869KM
PROFUNDI: 89.07+- 9.40KM
MAGNITUD: 4.1 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
SAL	237.13	337	118	25.5	39.9	0.7	0	53.5	-0.5	0	
GUI	462.62	331	50	51.5	68.9	-2.3	0	0.0	0.0	0	
MOR	358.46	334	50	40.0	55.9	-0.8	0	0.0	0.0	0	
SCH	364.37	325	50	43.0	56.6	1.5	0	82.0	-0.9	0	
CHI	316.65	150	50	45.0	50.6	9.5	4	0.0	0.0	0	
JUN	391.77	310	50	47.0	60.0	2.1	0	0.0	0.0	0	
SFE	363.79	317	50	40.5	56.5	-0.9	0	81.0	-1.8	0	
NNA	349.29	329	50	39.3	54.7	-0.3	0	82.5	2.8	0	4.1Mb

RMC= 1.892

1020

PICENTRO NO. 20
PERU, 17 SET 1986
HORA: 1H 2M 29.33S GMI
LATITUD: 12.7155+- 0.02088 2.3029KM
LONGITUD: 76.9166+- 0.0246W 2.6698KM
PROFUNDI: 46.38+- 5.69KM
MAGNITUD: 3.9 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	142.42	334	117	52.0	23.6	-0.9	0	0.0	0.0	0	
GUI	57.71	295	130	41.1	11.6	0.2	0	48.7	-0.7	0	
MOR	60.40	168	129	42.7	11.9	1.5	0	50.7	0.8	0	
SCH	93.05	206	121	45.9	16.3	0.3	0	56.8	-0.8	0	
SFE	139.21	214	117	52.9	23.1	0.5	0	68.4	-0.9	0	
JUN	183.58	225	115	60.5	29.9	1.3	0	81.1	0.1	0	
SAL	180.24	155	116	58.1	29.3	-0.6	0	78.2	-1.9	0	
HUA	188.65	246	115	60.4	30.6	0.4	0	81.0	-0.5	0	
NNA	81.03	185	123	45.0	14.6	1.0	0	54.5	-0.2	0	3.9Mb

RMC= 0.990

PICENTRO NO. 21
PERU, 17 SET 1986
HORA: 1H 9M 15.03S GMI
LATITUD: 12.6930+- 0.0353S 3.9067KM
LONGITUD: 76.6449+- 0.0754W 8.1797KM
PROFUNDI: 66.30+- 9.91KM
MAGNITUD: 3.2 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	134.85	346	121	39.3	23.6	0.7	0	55.4	-0.5	0	
GUI	35.49	320	152	27.9	11.8	1.1	0	35.2	-0.2	0	
MOR	70.39	143	134	29.5	15.1	-0.7	0	41.6	0.3	0	
SCH	81.88	187	130	32.8	16.5	1.3	0	43.6	-0.0	0	
SFE	122.65	203	123	37.8	21.9	0.9	0	54.3	1.4	0	
SAL	192.38	146	117	47.0	32.0	-0.1	0	0.0	0.0	0	
HUA	160.87	243	119	31.8	27.4	-10.6	3	46.4	-16.0	4	
NNA	80.89	164	131	31.8	16.4	0.4	0	41.4	-2.0	0	3.2Mb

RMC= 2.003

PICENTRO NO. 22
PERU, 17 SET 1986
HORA: 6H26M 18.31S GMI
LATITUD: 15.6300+- 0.10628 11.7516KM
LONGITUD: 74.4566+- 0.1203W 12.8823KM
PROFUNDI: 100.00+- 0.00KM
MAGNITUD: 4.1 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	281.15	133	114	3.4	45.2	-0.1	0	37.3	0.8	0	
GUI	366.18	144	114	12.1	55.8	-2.0	0	53.2	-1.8	0	
SCH	464.20	151	114	26.8	68.1	0.4	0	0.0	0.0	0	
HUA	408.25	166	114	20.4	61.1	1.0	0	63.4	-0.7	0	
MOR	471.98	143	114	26.8	69.0	-0.6	0	0.0	0.0	0	
NNA	478.15	147	114	29.3	69.8	1.2	0	80.5	1.3	0	4.1Mb

RMC= 1.455

PICENTRO NO. 23
PERU, 17 SET 1986
HORA: 12H44M 52.94S GMI
LATITUD: 10.6346+- 0.03188 3.5218KM
LONGITUD: 75.0435+- 0.0355W 3.8806KM
PROFUNDI: 12.91+- 0.00KM
MAGNITUD: 4.1 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
ANG	103.05	75	114	9.4	17.3	-0.8	0	22.0	-0.9	0	
JUN	124.88	35	114	13.6	20.7	-0.1	0	28.6	-0.3	0	
SFE	170.30	47	114	21.0	27.9	0.2	0	42.1	0.8	0	
SCH	219.29	48	114	29.2	35.6	0.6	0	0.0	0.0	0	
MOR	275.84	51	114	38.6	44.5	1.1	0	0.0	0.0	0	
SAL	287.87	76	114	39.4	46.4	0.0	0	0.0	0.0	0	
GUI	296.64	30	114	39.7	47.8	-1.1	0	0.0	0.0	0	
HUA	158.19	11	114	18.9	26.0	-0.0	0	37.4	-0.6	0	
NNA	246.29	52	114	33.6	39.9	0.8	0	61.8	-0.2	4	4.1Mb

RMC= 0.799

I PICENTRO NO. 24
PERU, 20 SET 1986
HORA: 7H 1M 34.47S GMI
LATITUD: 9.9249+- 0.09433 10.4999KM
LONGITUD: 77.1645+- 0.09609 6.1796KM
PROFUNDI: 100.00+- 0.00KM
MAGNITUD: 4.4 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
MOR	736.39	358	114	76.3	102.1	-0.3	0	190.7	-0.7	0	
SCH	715.09	354	114	74.7	99.9	0.0	0	146.3	-0.5	0	
JUN	685.07	346	114	74.7	95.7	4.8	4	146.1	9.9	4	
ETE	336.60	62	114	0.0	52.1	0.0	0	65.2	0.9	0	
CHI	327.81	65	114	0.0	51.0	0.0	0	63.1	0.3	0	
SAL	633.61	4	114	63.2	89.3	-0.9	0	126.9	-2.2	0	
HUA	748.25	344	114	77.0	103.6	-1.1	0	197.0	3.1	0	
NNA	715.68	357	114	73.7	99.9	-0.3	0	0.0	0.0	0	4.4Mb

RMC= 1.527

I PICENTRO NO. 25
PERU, 20 SET 1986
HORA: 14H14M 13.14S GMI
LATITUD: 10.1896+- 0.17078 18.0774KM
LONGITUD: 78.7263+- 0.1689W 10.4600KM
PROFUNDI: 46.70+- 37.64KM
MAGNITUD: 4.1 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
MOR	287.60	319	114	58.9	46.0	-0.3	0	93.2	0.4	0	
SCH	308.52	309	114	61.9	49.3	-0.5	0	99.1	0.6	0	
SAL	167.99	313	116	43.6	27.9	3.0	4	60.7	-0.0	0	
NNA	286.14	314	114	59.7	45.8	0.0	0	90.0	-2.4	2	4.1Mb

RMC= 1.163

I PICENTRO NO. 26
PERU, 20 SET 1986
HORA: 15H30M 46.38S GMI
LATITUD: 12.7471+- 0.06448 7.1220KM
LONGITUD: 76.7816+- 0.0905W 9.8129KM
PROFUNDI: 67.21+- 11.97KM
MAGNITUD: 3.4 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
MOR	68.18	156	135	63.2	19.0	1.8	0	73.6	1.2	0	
QUI	43.12	299	147	59.2	12.9	0.3	0	66.6	-1.4	0	
SCH	90.94	196	128	65.0	17.7	0.9	0	76.9	-0.2	0	
SAL	189.93	151	118	77.7	31.7	-0.4	0	98.9	-2.4	0	
NNA	84.32	175	130	86.0	16.9	22.7	4	97.9	21.8	4	3.4Mb

RMC= 1.676

I PICENTRO NO. 27
PERU, 21 SET 1986
HORA: 0H31M 13.23S GMI
LATITUD: 11.0742+- 0.06216 6.8692KM
LONGITUD: 76.8513+- 0.0439W 4.7396KM
PROFUNDI: 289.60+- 9.08KM
MAGNITUD:
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
SCH	106.65	340	158	28.9	16.3	-0.7	0	40.9	-0.6	0	
MOR	126.31	8	155	29.4	16.8	-0.6	0	42.2	-0.1	0	
QUI	214.16	347	141	32.9	19.9	0.1	0	46.6	-0.9	0	
SAL	83.80	75	163	29.6	19.9	0.9	0	0.0	0.0	0	
HUA	200.44	303	143	32.0	19.0	-0.3	0	46.0	-0.2	0	
NNA	103.61	358	159	0.0	16.3	0.0	0	0.0	0.0	0	

RMC= 0.568

I PICENTRO NO. 28
PERU, 21 SET 1986
HORA: 0H57M 43.92S GMI
LATITUD: 10.6418+- 0.1790S 19.3609KM
LONGITUD: 73.0818+- 0.1422W 19.9290KM
PROFUNDI: 53.45+- 14.03KM
MAGNITUD: 4.7 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	503.99	44	50	62.2	77.9	0.8	0	0.0	0.0	0	
QUI	444.72	55	50	55.6	70.1	1.6	0	0.0	0.0	0	
MOR	462.52	68	50	54.9	72.3	-1.7	0	0.0	0.0	0	
SCH	404.04	68	114	48.8	64.4	0.9	0	96.8	1.4	0	
SAL	498.41	82	50	60.7	76.8	-0.0	0	0.0	0.0	0	
HUA	288.82	57	115	30.0	46.4	-0.3	0	62.6	-1.6	0	
NNA	435.57	70	50	52.0	68.9	-0.8	0	0.0	0.0	4	4.7Mb

RMC= 1.539

1634

HIPICENTRO NO. 29
PERU, 21 SET 1986
HORA: 1H41M 58.05S GMI
LATITUD: 13.9497+- 0.02000 2.9044KM
LONGITUD: 76.1863+- 0.04699 9.0150KM
PROFUNDI: 59.71+- 9.47KM
MAGNITUD: 3.1 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
CUI	114.94	166	122	18.0	20.9	0.4	0	39.9	0.2	0	
PAR	19.32	114	162	8.0	9.0	0.1	0	14.0	-0.2	0	
SCH	223.45	170	116	34.1	36.0	-0.4	0	60.9	-0.3	0	
HUA	231.31	203	116	35.7	39.7	-0.0	0	0.0	0.0	0	
NNA	228.38	161	116	41.9	37.2	6.2	4	0.0	0.0	0	3.1Mb

RMC= 0.389

HIPICENTRO NO. 30
PERU, 21 SET 1986
HORA: 3H 0M 57.47S GMI
LATITUD: 12.7515+- 0.02170 2.4049KM
LONGITUD: 75.2779+- 0.02044 9.0775KM
PROFUNDI: 87.72+- 7.62KM
MAGNITUD: 3.3 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	170.10	42	122	27.0	30.1	0.2	0	0.0	0.0	0	
GUI	127.24	80	127	22.0	24.9	0.9	0	37.1	-0.4	0	
SCH	162.62	122	123	25.9	29.6	-0.6	0	48.2	0.4	0	
HUA	79.08	176	139	16.0	18.9	0.0	0	0.0	0.0	0	
NNA	189.42	116	121	38.0	32.0	7.7	4	60.7	6.4	4	3.3Mb

RMC= 0.537

HIPICENTRO NO. 31
PERU, 21 SET 1986
HORA: 6H 3M 58.02S GMI
LATITUD: 12.8261+- 0.03076 9.4009KM
LONGITUD: 77.0102+- 0.04764 9.1637KM
PROFUNDI: 51.37+- 10.96KM
MAGNITUD: 3.4 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
GUI	63.49	281	130	12.0	12.8	1.2	0	20.0	-0.1	0	
SCH	108.56	208	120	17.4	18.9	0.9	0	28.0	-1.9	0	
MOR	71.40	178	127	13.0	13.8	2.0	0	23.0	1.1	0	
HUA	202.93	244	116	32.1	33.0	1.1	0	54.9	-0.3	0	
PAR	136.50	328	118	21.9	22.9	0.3	0	39.7	-2.0	0	
SAL	187.63	159	116	28.1	30.7	-0.6	0	49.0	-2.1	0	
NNA	94.67	191	122	16.1	16.9	1.2	0	26.9	-0.8	0	3.4M

RMC= 1.495

HIPICENTRO NO. 32
PERU, 22 SET 1986
HORA: 5H20M 45.59S GMI
LATITUD: 11.1332+- 0.09228 9.7709KM
LONGITUD: 76.5394+- 0.0442M 4.0101KM
PROFUNDI: 100.00+- 0.00KM
MAGNITUD: 4.1 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	304.24	356	114	34.7	48.0	1.1	0	97.9	-10.9	4	
GUI	200.19	356	114	17.7	39.0	-2.9	4	40.9	-6.0	4	
MOR	127.61	24	114	10.7	29.9	-0.0	0	29.4	-2.1	0	
SCH	91.46	0	114	8.2	21.4	1.2	0	23.9	1.1	0	
SAL	117.36	84	114	10.7	24.7	0.4	0	28.2	-0.1	0	
HUA	166.07	307	114	14.7	30.8	-1.6	0	0.0	0.0	0	
NNA	99.92	19	114	8.8	22.9	0.7	0	24.9	-0.0	0	4.1M

RMC= 1.334

HIPICENTRO NO. 33
PERU, 22 SET 1986
HORA: 7H53M 24.25S GMI
LATITUD: 12.0813+- 0.02328 2.9719KM
LONGITUD: 76.7054+- 0.0258M 2.0046KM
PROFUNDI: 93.47+- 2.89KM
MAGNITUD: 4.4 Mb
INTENSID: III MM LIMA

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	202.38	349	121	59.0	39.1	-0.3	0	83.9	-1.1	0	
GUI	99.39	342	134	47.0	21.4	1.3	0	62.3	1.0	0	
HUA	150.44	268	125	52.9	27.8	0.4	0	72.0	-0.5	0	
MOR	36.96	72	159	40.7	15.8	0.7	0	91.1	-0.4	0	
SCH	22.43	233	167	39.3	19.1	-0.0	0	0.0	0.0	0	
SAL	135.86	133	127	46.4	25.9	-3.0	4	0.0	0.0	0	
CAM	28.66	91	163	40.0	19.3	0.4	0	90.0	-0.8	0	
ARE	742.12	310	50	127.0	103.9	-0.7	0	0.0	0.0	0	
NNA	17.88	125	169	39.9	14.9	0.3	0	49.9	-0.6	0	4.4

RMC= 0.802

EPICENTRO NO. 34
PERU, 22 SET 1986
HORA: 10H39M 41.37S GMT
LATITUD: 13.5500+- 0.0[illegible] 4.[illegible]KM
LONGITUD: 76.6640+- 0.0128[illegible] 4.97[illegible]KM
PROFUNDI: 53.50+- 7.0KM
MAGNITUD: 3.0 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	46.60	312	139	92.0	11.1	0.3	0	99.0	-0.0	0	
CUI	76.05	198	127	57.3	14.6	1.3	0	67.3	0.7	0	
SCH	160.03	184	116	70.9	29.7	-0.2	0	91.4	-1.4	0	
KNA	178.34	173	116	57.0	29.3	-13.7	4	64.9	-27.7	4	3.0Mb

RMC= 1.2[illegible]

EPICENTRO NO. 35
PERU, 22 SET 1986
HORA: 14H 6M 36.43S GMT
LATITUD: 10.5702+- 0.0[illegible] 2.60[illegible]KM
LONGITUD: 74.9410+- 0.0[illegible] 3.952[illegible]KM
PROFUNDI: 61.49+- 2.0KM
MAGNITUD: 4.1 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	374.45	22	50	38.0	43.0	-1.4	4	09.4	-0.2	0	
CUI	306.63	32	115	25.9	49.3	-0.3	0	62.0	0.1	0	
MOR	287.66	32	115	23.3	46.4	0.9	0	97.3	0.9	4	
SCH	250.91	43	116	14.2	37.7	0.1	0	41.6	-0.1	0	
SAL	279.91	76	115	24.3	40.3	-0.4	0	0.0	0.0	0	
HUA	165.44	14	118	3.0	27.0	-1.2	3	0.0	0.0	0	
KNA	258.16	53	115	18.9	41.9	0.6	0	40.9	-0.4	0	4.1Mb

RMC= 0.4[illegible]

EPICENTRO NO. 36
PERU, 22 SET 1986
HORA: 16H 7M 21.72S GMT
LATITUD: 10.6039+- 0.0193 2.1397KM
LONGITUD: 74.8881+- 0.019[illegible] 2.1655KM
PROFUNDI: 13.06+- 0.00KM
MAGNITUD: 4.3 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	395.33	23	114	84.2	63.4	-0.9	4	0.0	0.0	0	
CUI	308.45	33	114	71.4	49.7	-0.0	0	107.9	0.1	0	
MOR	291.32	33	114	69.1	47.0	0.4	0	102.9	-0.2	4	
SCH	234.31	30	114	60.2	30.0	0.3	0	07.4	-0.1	0	
SAL	305.16	76	114	70.3	49.2	-0.6	0	106.4	-0.3	0	
HUA	165.53	16	114	49.0	27.1	0.1	0	60.0	-0.3	0	
KNA	261.90	34	114	64.9	42.3	0.0	4	99.9	0.4	0	4.3Mb

RMC= 0.4[illegible]

EPICENTRO NO. 37
PERU, 22 SET 1986
HORA: 21H44M 6.21S GMT
LATITUD: 13.4251+- 0.04270 4.7227KM
LONGITUD: 76.8573+- 0.0630H 6.8076KM
PROFUNDI: 13.00+- 0.00KM
MAGNITUD: 4.0 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	75.97	310	114	18.7	13.0	-0.9	0	27.4	-1.4	0	
CUI	73.04	221	114	18.7	12.6	-0.1	0	27.0	-0.2	0	
MOR	139.37	173	114	30.2	23.0	1.0	0	49.4	-0.7	0	
SCH	167.17	192	114	32.1	27.4	-1.9	0	44.9	-9.2	4	
SAL	255.48	162	114	49.2	41.3	1.6	0	79.1	-2.7	4	
HUA	229.20	227	114	44.9	37.2	1.1	0	76.0	-0.6	0	
KNA	160.02	181	114	32.0	26.3	-0.9	0	49.4	-2.3	0	4.0Mb

RMC= 1.964

EPICENTRO NO. 38
PERU, 22 SET 1986
HORA: 22H59M 44.19S GMT
LATITUD: 14.7321+- 0.07648 8.4498KM
LONGITUD: 73.9597+- 0.0629H 6.7698KM
PROFUNDI: 120.00+- 0.00KM
MAGNITUD: 4.6 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	274.30	110	114	28.8	44.4	0.2	0	61.9	0.4	0	
CUI	332.86	126	114	35.6	51.7	-0.3	0	73.2	-0.6	0	
MOR	435.76	130	114	49.6	64.6	0.8	0	97.2	1.1	0	
SCH	414.70	137	114	46.0	62.0	-0.2	0	91.1	-0.4	0	
SAL	553.22	134	114	62.9	79.3	-0.6	0	120.6	-0.9	0	
HUA	332.50	153	114	37.4	51.7	1.9	0	70.9	-3.2	4	
KNA	435.02	134	114	47.0	64.9	-1.7	0	91.0	-44.9	4	4.6Mb

RMC= 1.026

[illegible]

EPICENTRO NO. 39
PERU, 23 SET 1986
HORA: 9H31M 51.05S GMT
LATITUD: 17.2092+- 0.19968 17.0997KM
LONGITUD: 73.4847+- 0.2291W 23.9291KM
PROFUNDI: 100.00+- 0.00KM
MAGNITUD: 4.4 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	479.77	140	114	2.9	70.0	1.4	0	91.0	-1.3	0	
GUI	568.87	146	114	12.9	01.2	0.3	0	71.2	-0.4	0	
MOR	674.52	145	114	27.2	94.4	1.0	0	99.1	0.6	0	
SCH	667.42	150	114	25.4	93.9	0.0	0	94.4	1.4	0	
HUA	605.36	160	114	14.9	09.7	-2.3	0	00.4	0.9	0	
NNA	681.31	148	114	24.9	99.2	-2.0	0	92.0	-4.0	2	4.4Mb

RMC= 1.912

EPICENTRO NO. 40
PERU, 23 SET 1986
HORA: 16H 3M 23.47S GMT
LATITUD: 16.6773+- 0.17103 10.9215KM
LONGITUD: 75.8483+- 0.3012W 40.6252KM
PROFUNDI: 100.00+- 0.00KM
MAGNITUD: 3.9 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	314.48	170	114	18.9	49.3	6.1	4	48.0	-0.9	0	
GUI	418.32	171	114	25.3	62.3	-0.9	0	70.7	-0.7	0	
MOR	513.51	165	114	33.9	74.2	-3.0	0	0.0	0.0	0	
SCH	527.23	171	114	37.6	76.0	-1.0	0	94.7	-0.3	0	
HUA	516.43	186	114	41.0	74.6	2.9	0	91.0	-1.7	0	
NNA	529.81	168	114	43.0	76.3	3.2	0	98.6	3.0	0	3.9Mb

RMC= 2.821

EPICENTRO NO. 41
PERU, 23 SET 1986
HORA: 18H17M 29.11S GMT
LATITUD: 12.0054+- 0.02768 3.0984KM
LONGITUD: 77.4052+- 0.0307W 3.3352KM
PROFUNDI: 54.56+- 4.78KM
MAGNITUD: 3.3 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
MOR	45.16	295	140	40.8	11.1	0.6	0	48.3	0.0	0	
SAL	88.02	165	125	45.4	16.2	0.0	0	96.9	-0.3	0	
SCH	94.19	266	123	46.7	17.1	0.9	0	98.9	-0.2	0	
GUI	147.49	314	118	53.0	24.7	-0.9	0	0.0	0.0	0	
NNA	61.58	268	132	42.9	12.9	0.9	0	91.0	-0.4	0	3.3Mb

RMC= 0.614

EPICENTRO NO. 42
PERU, 25 SET 1986
HORA: 1H10M 42.90S GMT
LATITUD: 10.0096+- 0.06370 7.0901KM
LONGITUD: 75.7043+- 0.0404W 9.3172KM
PROFUNDI: 100.00+- 0.00KM
MAGNITUD: 3.8 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
SAL	248.48	56	114	24.0	41.1	0.0	0	94.4	0.4	0	
MOR	280.33	31	114	27.0	49.1	-0.2	0	61.0	0.1	0	
GUI	333.81	13	114	33.6	91.0	-1.1	0	76.7	-1.0	0	
PAR	433.53	9	114	46.4	64.2	-0.7	0	0.0	0.0	0	
HUA	228.22	349	114	22.9	38.9	1.1	0	90.9	0.9	0	
NNA	251.31	29	114	24.9	41.4	0.2	0	99.9	0.8	0	3.8Mb

RMC= 1.054

EPICENTRO NO. 43
PERU, 25 SET 1986
HORA: 15H25M 53.88S GMT
LATITUD: 13.5247+- 0.09320 10.3149KM
LONGITUD: 72.1565+- 0.1027W 11.1019KM
PROFUNDI: 82.18+- 12.36KM
MAGNITUD: 4.3 Mb
INTENSID: III-IV CUZCO

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
GUI	467.64	97	50	63.9	70.2	-0.2	0	119.4	-0.0	0	
ARE	332.78	347	50	46.9	93.3	-0.7	0	86.9	0.3	0	
SAL	644.03	113	50	87.0	92.3	0.9	0	193.0	-0.7	0	
NNA	535.41	108	50	61.0	78.7	-11.9	4	190.0	19.9	4	4.3Mb

RMC= 0.741

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EPICENTRO NO.      44
    PERU, 26 SET 1986
    HORA:          1H32M 49.82S   GMI
    LATITUD:      14.9206+-      0.02040          2.2957KM
    LONGITUD:     75.9703+-      0.0104W          1.0705KM
    PROFUNDI:       90.54+-        0.94KM
    MAGNITUD:
    INTENSID:
     STA    DIST    AZM  AIN   P-SEC   TPCAL   P-RES WT    S-SEC   S-RES WT MAG
     QUI   238.20   156  119    26.9    40.1    -3.4  4     93.0    -6.3  4
     PAR   142.68   144  126    16.0    26.6     0.4  0     39.9    -0.3  0
     MOR   341.68   152   50     0.0    93.6     0.0  0     70.9    -4.2  4
     SAL   463.65   151   50    58.9    68.9    -0.2  0    109.0    -0.1  0
     HUA   320.05   184   50    40.9    80.9    -0.2  0     70.0     0.0  0
     NNA   352.34   157   50    50.0    99.0     9.2  4     09.0     0.0  0
  RMC=      0.287
EPICENTRO NO.      45
    PERU, 27 SET 1986
    HORA:          4H56M  8.86S   GMI
    LATITUD:      12.2750+-      0.03078          3.4010KM
    LONGITUD:     77.1310+-      0.0324W          3.9190KM
    PROFUNDI:       62.52+-        4.21KM
    MAGNITUD:      3.5 Mb
    INTENSID:
     STA    DIST    AZM  AIN   P-SEC   TPCAL   P-RES WT    S-SEC   S-RES WT MAG
     MOR    15.11   226  167    19.4    10.1     0.9  0     26.9     0.6  0
     QUI   105.34   314  124    27.0    19.2    -0.3  0     41.3    -0.8  0
     SAL   126.24   155  121    30.0    22.1    -0.2  0     46.4    -0.0  0
     HUA   198.29   262  117    42.9    32.7     0.9  0     69.2    -0.4  0
     NNA    44.96   224  144    22.0    12.0     1.1  0     28.9    -0.8  0 3.5Mb
  RMC=      0.885
EPICENTRO NO.      46
    PERU, 27 SET 1986
    HORA:          5H42M  4.85S   GMI
    LATITUD:       9.5698+-      0.14668          16.2173KM
    LONGITUD:     75.4159+-      0.1279W          13.9576KM
    PROFUNDI:      100.00+-        0.00KM
    MAGNITUD:      4.2 Mb
    INTENSID:
     STA    DIST    AZM  AIN   P-SEC   TPCAL   P-RES WT    S-SEC   S-RES WT MAG
     SAL   302.47    52  114    53.0    47.8     0.3  0     89.7    -2.0  0
     MOR   338.29    31  114    57.9    52.3     0.7  0     93.8    -1.7  0
     QUI   389.03    16  114    66.0    58.7     2.9  0    107.6     1.1  0
     PAR   487.17    12  114    71.8    70.9    -4.0  0      0.0     0.0  0
     HUA   273.22   357  114    49.3    44.2     0.3  0     80.0    -1.4  0
     NNA   309.21    30  114    54.9    48.7     1.0  0     91.7     2.9  0 4.2Mb
  RMC=      2.391
EPICENTRO NO.      47
    PERU, 28 SET 1986
    HORA:          9H 5M 55.09S   GMI
    LATITUD:       9.3146+-      0.19903          17.1432KM
    LONGITUD:     80.0258+-      0.3691W          39.7069KM
    PROFUNDI:       15.00+-        0.00KM
    MAGNITUD:
    INTENSID:
     STA    DIST    AZM  AIN   P-SEC   TPCAL   P-RES WT    S-SEC   S-RES WT MAG
     MOR   455.46   314  114    64.2    72.9    -3.0  0    109.4   -19.9  4
     ETE   262.68   183  114    40.6    42.9     3.0  0     66.6    -2.1  0
     SAL   338.86   308  114    70.9    94.9    21.9  4     90.9     1.0  0
     NNA   456.55   310  114    69.7    73.0     1.6  0    103.9   -13.1  4
  RMC=      3.524
EPICENTRO NO.      48
    PERU, 28 SET 1986
    HORA:         14H25M  8.67S   GMI
    LATITUD:       9.8082+-      0.09788          6.3914KM
    LONGITUD:     80.0574+-      0.1199W          12.6429KM
    PROFUNDI:      100.00+-        0.00KM
    MAGNITUD:      4.2 Mb
    INTENSID:
     STA    DIST    AZM  AIN   P-SEC   TPCAL   P-RES WT    S-SEC   S-RES WT MAG
     MOR   421.80   308  114    71.0    62.0    -0.4  0      0.0     0.0  0
     ETE   317.39   183  114    58.3    49.7    -0.1  0     94.7    -0.0  0
     SAL   310.38   300  114    57.3    48.8    -0.2  0    101.3     0.1  4
     CHI   337.25   183  114    60.9    92.2    -0.4  0      0.0     0.0  0
     SCH   451.58   301  114    75.0    66.9    -0.2  0    123.0    -0.0  0
     HUA   572.45   295  114    92.4    81.6     2.1  0      0.0     0.0  0
     NNA   425.88   304  114    71.7    63.3    -0.2  0    131.0    12.7  4 4.2Mb
  RMC=      0.970
```

10SA

```
I-PICENTRO NO.      49
    PERU,28 SET 1986
    HORA:           14H28M  6.36S   GMI
    LATITUD:        10.4197+-      0.09303          9.0412KM
    LONGITUD:       81.1141+-      0.0927W          9.999CKM
    PROFUNDI:         96.12+-        4.24KM
    MAGNITUD:        4.3 Mb
    INTENSID:
     STA    DIST    AZM  AIN   P-SEC   TPCAL   P-RES WT    G-SEC   G-RES WT MAG
     MOR   485.96   293   50    22.2    79.0    0.9  0      0.0     0.0  0
     ETE   407.62   199  114    11.4    69.0    0.0  0      0.0     0.0  0
     SAL   392.88   283  114     8.9    62.7   -0.9  0     99.1     0.2  0
     SCH   527.02   288   50    26.0    80.1   -0.9  0     76.0    -9.1  4
     NNA   497.32   290   50    22.0    76.4    0.0  0     70.9    -0.4  0 4.3Mb
  RMC=      0.635
I-PICENTRO NO.      50
    PERU,28 SET 1986
    HORA:           14H43M 22.39S   GMI
    LATITUD:        11.3963+-      0.09960          6.1479KM
    LONGITUD:       74.9603+-      0.09309          9.6547KM
    PROFUNDI:        100.00+-        0.00KM
    MAGNITUD:        4.1 Mb
    INTENSID:
     STA    DIST    AZM  AIN   P-SEC   TPCAL   P-RES WT    G-SEC   G-RES WT MAG
     PAR   312.81    28  114    70.6    49.1   -0.9  0      0.0     0.0  0
     GUI   234.04    43  114    62.4    37.3    0.7  0     90.1    -0.3  0
     MOR   241.21    68  114    62.7    40.2    0.1  0     90.7    -1.3  0
     SAL   289.37    93  114    68.0    46.2   -0.6  0    101.0    -0.6  0
     SCH   182.78    70  114    55.0    32.0   -0.2  0     80.8     0.7  0
     NNA   214.55    72  114    60.9    36.0    1.3  0     86.8     0.6  0 4.1Mb
  RMC=      0.943
I-PICENTRO NO.      51
    PERU,28 SET 1986
    HORA:           15H 2M 34.19S   GMI
    LATITUD:        10.8894+-      0.04988          9.9064KM
    LONGITUD:       76.6743+-      0.0273W          2.9769KM
    PROFUNDI:        100.00+-        0.00KM
    MAGNITUD:        4.0 Mb
    INTENSID:
     STA    DIST    AZM  AIN   P-SEC   TPCAL   P-RES WT    G-SEC   G-RES WT MAG
     GUI   228.33   353  114    72.9    38.9   -0.2  0      0.0     0.0  0
     MOR   148.04    15  114    62.1    28.9   -0.6  0      0.0     0.0  0
     SCH   119.34   352  114    60.2    24.9    1.1  0     78.4     1.1  0
     SAL   109.10    69  114    58.0    23.6    0.2  0     74.9    -0.2  0
     HUA   194.51   310  114    68.4    34.3   -0.1  0     93.0    -0.6  0
     NNA   122.74     8  114    59.8    25.3    0.3  0     77.0    -1.1  0 4.0M
  RMC=      0.853
I-PICENTRO NO.      52
    PERU,28 SET 1986
    HORA:           17H13M 24.65S   GMI
    LATITUD:        12.0703+-      0.03496          3.0649KM
    LONGITUD:       78.1274+-      0.0311W          9.9766KM
    PROFUNDI:         60.93+-        10.09KM
    MAGNITUD:        4.6 Mb
    INTENSID:
     STA    DIST    AZM  AIN   P-SEC   TPCAL   P-RES WT    G-SEC   G-RES WT MAG
     MOR   119.88   275  122    45.9    21.1    0.1  0      0.0     0.0  0
     SCH   172.99   265  118    53.2    20.9   -0.3  0     74.9     0.2  0
     SAL   108.06   211  123    44.2    19.9    0.1  0     99.3    -0.1  0
     NNA   140.36   266  120    48.0    24.0    0.1  0     66.0    -0.3  0 4.6M
  RMC=      0.315
I-PICENTRO NO.      53
    PERU,29 SET 1986
    HORA:           5H15M 16.68S   GMI
    LATITUD:        10.1478+-      0.11926          13.1833KM
    LONGITUD:       75.3739+-      0.1231W          13.4602KM
    PROFUNDI:        100.00+-        0.00KM
    MAGNITUD:        3.9 Mb
    INTENSID:
     STA    DIST    AZM  AIN   P-SEC   TPCAL   P-RES WT    G-SEC   G-RES WT MAG
     ANG   101.90    38  114    34.9    22.7   -4.9  2     46.9    -9.1  4
     JUN   159.41    13  114    46.0    29.9   -0.6  0     67.7    -0.8  0
     SFE   191.31    27  114    50.7    33.9    0.1  0     76.3     0.9  0
     SCH   237.40    32  114    58.8    39.7    2.4  2      0.0     0.0  0
     SAL   272.27    63  114    60.8    44.0    0.1  0     92.4    -0.6  0
     NNA   258.68    38  114    61.0    42.3    2.0  0     99.9     9.9  4 3.9M
  RMC=      2.029
```

```
EPICENTRO NO.      54
    PERU, 29 OET 1986
    HORA:          5H36M  2.46S   CMI
    LATITUD:      14.6324+-     0.17770          19.0[illegible]KM
    LONGITUD:     74.2930+-     0.1402H          19.0921KM
    PROFUNDI:       64.87+-       10.06KM
    MAGNITUD:      3.6 Mb
    INTENSID:
     STA    DIST    AZM  AIN  P-SEC  TPCAL  P-REO HT   O-GEC  O-REO HT MAO
     PAR   236.84   110  116   40.9   33.7   -0.7  0    70.0    0.9  0
     GUI   297.69   128  115   49.7   40.1   -0.0  0    09.9    0.2  0
     SCH   382.78   140   50   63.9   61.2   -0.2  0   109.6    1.1  0
     NNA   401.91   136   50   67.7   63.6    1.6  0   110.9   -2.2  0 3.6Mb
  RMC=      1.564
EPICENTRO NO.      55
    PERU, 29 SET 1986
    HORA:          12H39M 27.09S   CMI
    LATITUD:      12.9049+-     0.00410          0.4807KM
    LONGITUD:     76.6593+-     0.0137H          1.4040KM
    PROFUNDI:       59.59+-       0.06KM
    MAGNITUD:
    INTENSID:
     STA    DIST    AZM  AIN  P-SEC  TPCAL  P-REO HT   O-GEC  O-REO HT MAO
     GUI    24.50   279  158   37.2   10.1    0.0  0    44.9   -0.0  0
     SCH   105.33   187  123   46.0   19.0   -0.1  0    60.0    0.0  0
     SFE   144.97   200  119   51.0   24.6    0.1  0    69.7   -0.1  0
  RMC=      0.089
EPICENTRO NO.      56
    PERU, 29 SET 1986
    HORA:          14H31M 23.39S   CMI
    LATITUD:      13.4022+-     0.01426          1.9666KM
    LONGITUD:     75.5030+-     0.0964H          6.1040KM
    PROFUNDI:        6.74+-       10.02KM
    MAGNITUD:
    INTENSID:
     STA    DIST    AZM  AIN  P-SEC  TPCAL  P-REO HT   O-GEC  O-REO HT MAO
     GUI   113.20   116   56   43.0   19.3    0.3  0    96.9   -0.4  0
     PAR   105.43    60   56   41.6   10.1    0.1  0    94.7   -0.1  0
     MOR   213.66   129   56   58.2   39.2   -0.4  0    04.0    0.9  0
     SCH   195.20   144   56   55.7   32.3    0.0  0    79.1   -0.2  0
  RMC=      0.403
EPICENTRO NO.      57
    PERU, 29 SET 1986
    HORA:          17H41M 50.99S   CMI
    LATITUD:      12.5809+-     0.01408          1.9441KM
    LONGITUD:     76.9480+-     0.0178H          1.0961KM
    PROFUNDI:       48.09+-       3.37KM
    MAGNITUD:      3.0 Mb
    INTENSID:
     STA    DIST    AZM  AIN  P-SEC  TPCAL  P-REO HT   O-GEC  O-REO HT MAO
     MOR    45.13   168  137    1.2   10.3   -0.1  0     0.7   -0.1  0
     GUI    68.26   305  127    4.2   13.1    0.1  0    13.9   -0.3  0
     SCH    81.74   212  124    5.0   14.9   -0.1  0    16.3   -0.4  0
     SFE   129.35   219  118   12.9   21.7    0.2  0    30.3   -0.3  0
     SAL   165.32   154  116   17.7   27.1   -0.4  0    37.6   -0.4  0
     NNA    66.76   190  127    5.0   12.9    1.1  0    13.7    0.4  0 3.0Mb
  RMC=      0.516
EPICENTRO NO.      58
    PERU, 30 SET 1986
    HORA:          7H43M 48.70S   CMI
    LATITUD:      15.0180+-     0.06608          7.3860KM
    LONGITUD:     73.7826+-     0.0902H          9.4621KM
    PROFUNDI:       53.58+-       3.49KM
    MAGNITUD:
    INTENSID:
     STA    DIST    AZM  AIN  P-SEC  TPCAL  P-REO HT   O-GEC  O-REO HT MAO
     PAR   303.86   114  115   37.4   46.7   -0.0  0    72.9   -0.2  0
     GUI   367.20   128  114   47.6   98.6    0.3  0    90.0   -0.2  0
     HUA   369.31   153  114   53.9   58.9    6.3  4     0.0    0.0  0
     SCH   450.94   138   50   58.8   70.8   -0.7  0     0.0    0.0  0
     NNA   470.79   135   50   62.9   73.3    0.5  0   119.7    0.0  0
  RMC=      0.506
```

106a

EPICENTRO NO. 59 PAG. 49

PERU, 30 SET 1986
HORA: 19H50M 16.61S GMT
LATITUD: 19.3690+- 0.06108 6.0410KM
LONGITUD: 73.6114+- 0.0990M 6.2102KM
PROFUNDI: 24.69+- 2.99KM
MAGNITUD: 5.0 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	338.05	119	114	9.7	93.7	-0.0	0	49.7	0.1	0	
QUI	407.28	131	114	20.9	64.6	-0.3	0	0.0	0.0	0	
MOR	511.82	134	50	37.9	80.9	-0.0	0	0.0	0.0	0	
SCH	493.90	140	114	33.7	70.3	-1.2	0	92.0	-0.2	0	
SFE	496.61	146	114	42.2	70.7	4.9	4	0.0	0.0	0	
JUN	482.17	152	114	38.0	76.4	9.0	4	0.0	0.0	0	
SAL	630.95	136	50	53.2	99.0	0.7	0	122.2	-0.4	0	
CAM	515.46	135	50	38.0	01.4	0.0	0	97.0	-0.6	0	
NNA	512.89	137	50	39.0	81.1	1.3	0	97.3	0.3	0	5.0Mb

RMC= 0.735

EPICENTRO NO. 60

PERU, 30 SET 1986
HORA: 18H32M 12.44S GMT
LATITUD: 14.5092+- 0.04498 4.9199KM
LONGITUD: 76.9475+- 0.0766M 0.2486KM
PROFUNDI: 83.01+- 3.29KM
MAGNITUD: 3.2 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	95.17	222	132	33.1	19.8	0.0	0	46.6	-0.2	0	
QUI	182.19	197	120	44.3	31.5	0.4	0	66.5	-0.5	0	
SCH	285.45	188	117	58.4	46.9	-0.9	0	92.7	-0.9	0	
SFE	323.81	194	50	63.0	52.1	-0.0	0	103.2	0.5	0	
NNA	279.29	182	117	58.5	49.4	0.1	0	93.0	1.0	0	3.2Mb

RMC= 0.884

EPICENTRO NO. 61

PERU, 30 SET 1986
HORA: 21H11M 59.26S GMT
LATITUD: 12.5487+- 0.02328 2.5706KM
LONGITUD: 77.2105+- 0.0284M 3.0332KM
PROFUNDI: 46.53+- 9.67KM
MAGNITUD: 4.0 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
QUI	94.48	297	121	15.9	16.5	0.1	0	26.8	-1.1	0	
MOR	45.15	205	136	10.3	10.1	0.9	0	17.0	0.2	0	
SCH	97.70	228	120	16.6	17.0	0.4	0	28.7	0.0	0	
SFE	146.72	228	117	24.0	24.2	0.5	0	40.0	-0.4	0	
SAL	151.60	163	116	24.1	25.0	-0.1	0	41.3	-1.2	0	
NNA	74.09	213	125	13.0	13.7	0.0	0	22.7	-0.3	0	4.0Mb

RMC= 0.762

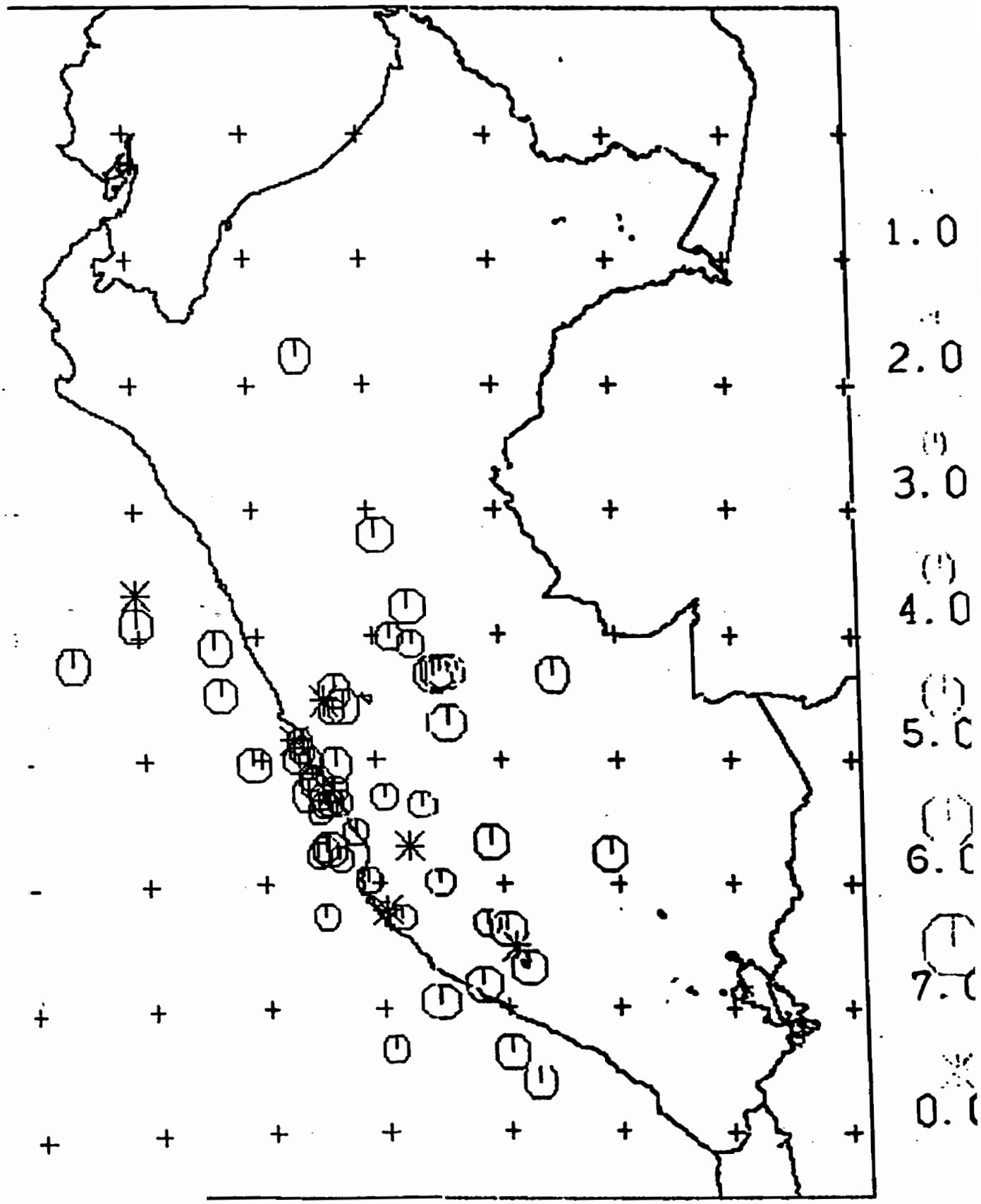
EPICENTRO NO. 62

PERU, 30 SET 1986
HORA: 23H38M 56.46S GMT
LATITUD: 13.9761+- 0.03938 7.0629KM
LONGITUD: 75.0283+- 0.0282M 9.5119KM
PROFUNDI: 14.21+- 31.69KM
MAGNITUD: 3.6 Mb
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
PAR	143.90	97	114	19.5	23.0	0.0	0	39.0	-0.5	0	
QUI	194.90	128	114	27.3	31.8	-0.9	0	50.2	-1.3	0	
SCH	282.34	144	114	41.5	49.6	-0.5	0	73.1	-2.3	0	
NNA	300.03	139	114	43.7	48.4	-1.1	0	79.5	-0.7	0	3.6Mb

RMC= 1.481

INSTITUTO GEOFISICO DEL PERU



MAP OF PRELIMINARY EPICENTERS

MAPA DE EPICENTROS PRELIMINARES

SETIEMBRE 1986

BEST AVAILABLE COPY

EVENTO # 87308002

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1.2
04 NOV 1987   03H 43M
 GUAO 69.1 0 88.0
 CAHX 68.2 0 84.3
 PARO 60.5 0 71.7
 QUIO 58.5
 MORO 66.2 0 81.7
 SCHO 70.5 0 88.7
 SFTO 77.2
 JUNO 84.8
 BALO 81.5
HALT
13 4.77.0.37.0.0.00
1
```


EPICENTRO NO. 1

PERU, 04 NOV 1987
HORA: 3H43M 44.268 GMT
LATITUD: 13.3512+- 0.0628 2.9028KM
LONGITUD: 77.0551+- 0.0521W 5.6330KM
PROFUNDI: 37.69+- 13.72KM
MAGNITUD:
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
GUA	154.21	297	115	69.1	29.0	-0.2	0	88.0	0.4	0	
CAH	141.49	183	116	68.2	23.1	0.9	0	84.3	0.1	0	
PAR	95.95	307	118	60.5	16.2	0.1	0	71.7	-0.6	0	
QUI	81.00	235	120	58.5	14.0	0.2	0	0.0	0.0	0	
MOR	129.48	181	116	66.2	21.2	0.7	0	81.7	0.7	0	
SCH	163.73	199	115	70.5	26.5	-0.3	0	88.7	-1.5	0	
SFE	207.49	206	114	77.2	33.3	-0.4	0	0.0	0.0	0	
JUN	246.78	216	114	84.8	39.4	1.1	0	0.0	0.0	0	
BAL	241.65	165	114	81.5	38.6	-1.4	0	0.0	0.0	0	

RMC= 0.878

BEST AVAILABLE COPY

EVENTO # 87 166 003

REPORTED TO CIVIL DEFENSE: 41 Km to the west of Mala
REPORTADO A DEFENSA CIVIL : A 41 Km. AL OESTE DE LA LOCALIDAD DE MALA

EPICENTRO NO. 1

PERU, 15 JUN 1987
HORA: 6H23M 6.06S GMT
LATITUD: 12.6725+- 0.0301S 3.3316KM
LONGITUD: 77.0355+- 0.0542W 5.8804KM
PROFUNDI: 67.42+- 4.39KM
MAGNITUD: 5.2 Mb.
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
MOR	54.37	180	141	20.4	13.6	0.8	0	0.0	0.0	0	
QUI	71.40	294	134	21.8	15.4	0.4	0	0.0	0.0	0	
SCH	95.43	214	127	23.6	18.3	-0.8	0	0.0	0.0	0	
SFE	143.20	219	121	30.7	24.9	-0.2	0	0.0	0.0	0	
PAR	152.56	330	120	32.9	26.2	0.6	0	0.0	0.0	0	
SAL	170.79	158	119	34.4	28.9	-0.5	0	0.0	0.0	0	
JUN	189.83	229	118	38.4	31.7	0.6	0	0.0	0.0	0	
GUA	198.89	317	117	36.4	33.1	-0.7	0	0.0	0.0	0	
CHI	723.12	154	50	108.7	103.6	-0.9	0	186.1	0.6	0	

RMC= 0.876

REPLICAS
AFTERSHOCKS

EPICENTRO NO. 1

PERU, 15 JUN 1987
HORA: 6H35M 55.72S GMT
LATITUD: 12.5596+- 0.0045S 0.4991KM
LONGITUD: 76.8606+- 0.0204W 2.2142KM
PROFUNDI: 37.51+- 2.90KM
MAGNITUD:
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
QUI	62.37	312	123	7.1	11.4	0.0	0	15.4	-0.0	0	
SCH	74.92	207	121	8.7	13.1	-0.1	0	18.5	0.1	0	
SFE	121.64	216	116	15.9	20.0	0.1	0	30.3	-0.1	0	

RMC= 0.164

EPICENTRO NO. 2

PERU, 15 JUN 1987
HORA: 6H45M 4.77S GMT
LATITUD: 12.5726+- 0.0110S 1.2168KM

LONGITUD: 76.8023+- 0.0198W 2.1533KM
PROFUNDI: 44.23+- 3.99KM
MAGNITUD:
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
QUI	56.83	315	129	16.0	11.2	-0.0	0	24.3	0.0	0	
SCH	73.52	202	124	17.7	13.4	-0.5	0	27.7	-0.3	0	
SFE	119.17	213	118	24.7	20.0	-0.1	0	39.8	0.4	0	
CAM	57.95	161	128	16.5	11.4	0.3	0	24.5	-0.0	0	

RMC= 0.412

EPICENTRO NO. 3

PERU, 15 JUN 1987
HORA: 6H57M 24.67S GMT
LATITUD: 12.5626+- 0.0063S 0.7003KM
LONGITUD: 76.7844+- 0.0286W 3.1031KM
PROFUNDI: 42.68+- 3.21KM
MAGNITUD:
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
QUI	56.30	317	128	35.8	11.0	0.1	0	43.7	-0.1	0	
SCH	71.76	201	123	37.5	13.1	-0.2	0	47.4	0.1	0	
SFE	117.17	213	117	44.4	19.6	0.1	0	58.5	-0.1	0	

RMC= 0.231

EPICENTRO NO. 4

PERU, 15 JUN 1987
HORA: 7H 1M 34.12S GMT
LATITUD: 12.5514+- 0.0040S 0.4376KM
LONGITUD: 76.8019+- 0.0181W 1.9671KM
PROFUNDI: 44.10+- 2.01KM
MAGNITUD:
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
QUI	58.50	317	128	45.6	11.4	0.0	0	53.9	-0.0	0	
SCH	71.33	203	124	47.1	13.1	-0.1	0	56.9	0.1	0	
SFE	117.19	214	118	53.9	19.7	0.1	0	68.1	-0.1	0	

RMC= 0.146

EPICENTRO NO. 5

PERU, 15 JUN 1987
HORA: 7H11M 15.02S GMT
LATITUD: 12.5688+- 0.0047S 0.5171KM
LONGITUD: 76.8946+- 0.0207W 2.2477KM
PROFUNDI: 33.45+- 3.56KM
MAGNITUD:
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
QUI	64.49	309	121	26.5	11.4	0.1	0	34.6	-0.1	0	
SCH	77.58	209	119	28.3	13.2	0.0	0	37.9	-0.0	0	

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SFE	124.67	217	115	35.2	20 3	-0.2	0	50.3	0.1	0

RMC= 0.167

EPICENTRO NO. 6

PERU, 15 JUN 1987
HORA: 7H18M 16.71S GMT
LATITUD: 12.5453+- 0.0093S 1.0297KM
LONGITUD: 76.7713+- 0.0170W 1.8461KM
PROFUNDI: 12.34+- 0.00KM
MAGNITUD:
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WI	S-SEC	S-RES	WT	MA
QUI	56.82	320	114	26.3	10 0	-0.4	0	34.5	0.5	0	
SCH	69.46	201	114	28.5	12 0	-0.2	0	37.7	0.2	0	
SFE	114.80	213	114	35.6	19.1	-0.3	0	49.8	-0.1	0	
CAM	56.28	157	114	26.5	9.9	-0.1	0	34.2	0.3	0	

RMC= 0.419

EPICENTRO NO. 7

PERU, 15 JUN 1987
HORA: 7H37M 37.21S GMT
LATITUD: 12.5249+- 0.0142S 1.5720KM
LONGITUD: 76.7627+- 0.0270W 2.9249KM
PROFUNDI: 3.74+- 4.38KM
MAGNITUD:
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WI	S-SEC	S-RES	WT	M
QUI	58.00	322	114	47.6	10.5	-0.1	0	55.7	0.3	0	
SCH	67.01	201	114	48 7	12 1	-0.6	0	58.3	0.1	0	
SFE	112.39	213	56	56.5	19.5	-0.2	0	71.1	0.2	0	
CAM	54.58	155	114	46.5	9.9	-0.6	0	55.0	0.7	0	

RMC= 0.607

EPICENTRO NO. 8

PERU, 15 JUN 1987
HORA: 8H25M 57.22S GMT
LATITUD: 12.5447+- 0.0136S 1.4992KM
LONGITUD: 76.8275+- 0.0290W 3.1452KM
PROFUNDI: 28.03+- 8.29KM
MAGNITUD:
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WI	S-SEC	S-RES	WT	M
QUI	60.94	315	119	7.3	10.5	-0.4	0	15.6	0.2	0	
SCH	71.82	205	117	9.1	12.1	-0.2	0	18.1	-0.1	0	
SFE	118.18	215	115	15.9	19.2	-0.5	0	30.3	-0.1	0	
JUN	163.56	227	114	24.2	26.2	0.7	0	0.0	0.0	0	
CAM	54.18	163	120	7.0	9.5	0.3	0	0.0	0.0	0	

RMC= 0.529

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EPICENTRO NO. 9

PERU, 15 JUN 1987
HORA: 8H32M 9.69S GMT
LATITUD: 12.5589+- 0.0103S 1.1394KM
LONGITUD: 76.8334+- 0.0157W 1.6999KM
PROFUNDI: 34.42+- 5.70KM
MAGNITUD:
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
QUI	60.29	314	122	20.5	10.8	-0.0	0	28.5	0.0	0	
SCH	73.52	205	120	22.1	12.7	-0.3	0	0.0	0.0	0	
SFE	119.83	215	116	29.5	19.6	0.2	0	43.7	-0.0	0	
CAM	55.51	164	124	20.0	10.2	0.1	0	0.0	0.0	0	

RMC= 0.264

EPICENTRO NO. 10

PERU, 15 JUN 1987
HORA: 8H41M 42.53S GMT
LATITUD: 12.5590+- 0.0149S 1.6501KM
LONGITUD: 76.7893+- 0.0271W 2.9401KM
PROFUNDI: 46.58+- 5.29KM
MAGNITUD:
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
QUI	56.95	317	130	54.0	11.5	-0.0	0	62.5	0.1	0	
SCH	71.59	202	125	55.8	13.4	-0.1	0	65.0	-0.7	0	
SFE	117.13	213	118	62.7	19.8	0.4	0	77.1	0.3	0	
CAM	56.99	159	130	53.5	11.5	-0.5	0	63.0	0.5	0	

RMC= 0.565

EPICENTRO NO. 11

PERU, 15 JUN 1987
HORA: 8H43M 17.03S GMT
LATITUD: 12.5768+- 0.0044S 0.4886KM
LONGITUD: 76.8528+- 0.0194W 2.1052KM
PROFUNDI: 32.49+- 3.22KM
MAGNITUD:
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
QUI	60.46	311	121	27.9	10.7	0.1	0	35.5	-0.1	0	
SCH	76.22	206	118	30.0	13.0	-0.0	0	39.5	-0.0	0	
SFE	122.67	215	115	36.9	20.0	-0.1	0	51.7	0.0	0	

RMC= 0.158

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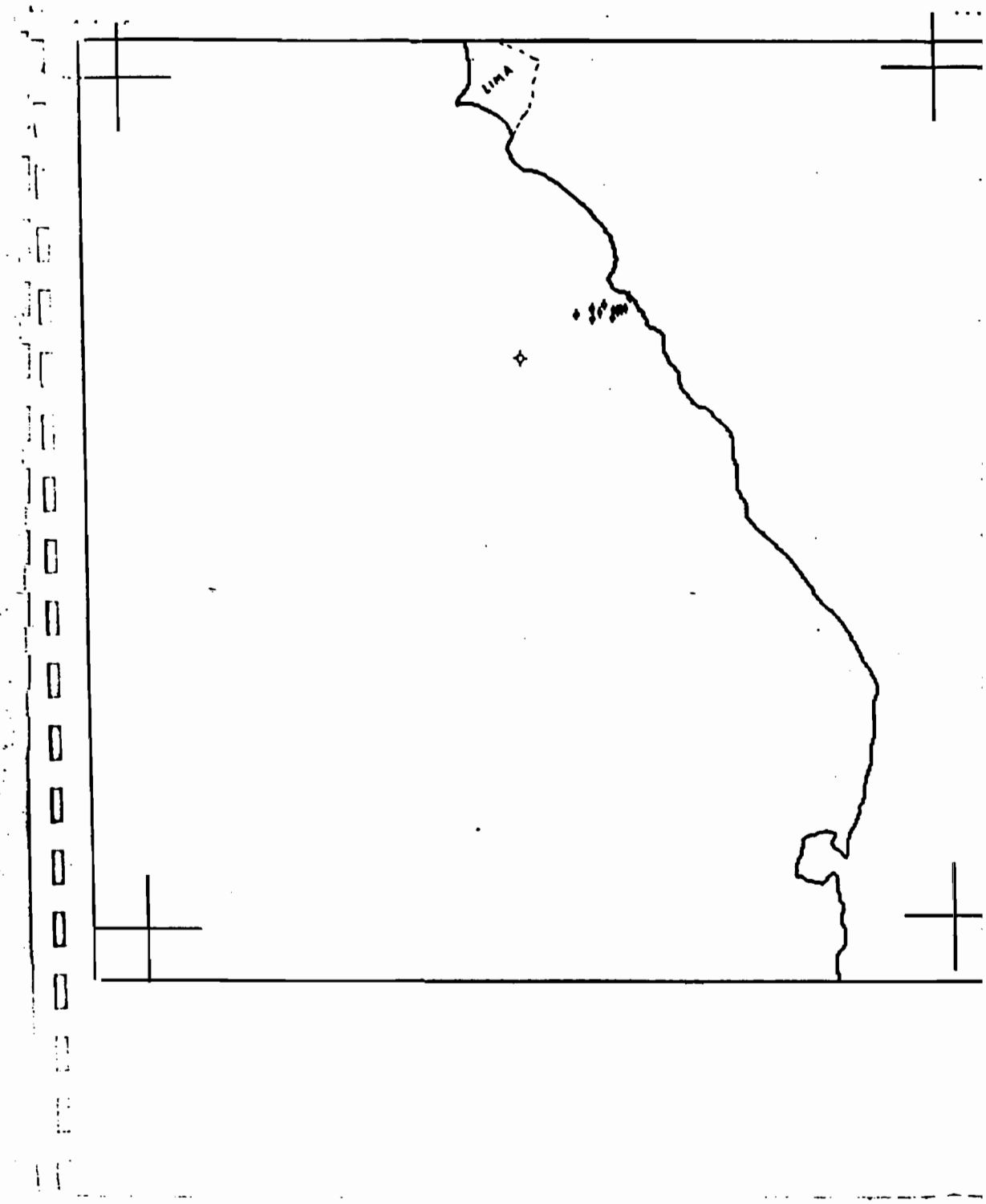
LIMA

EVENTO # 87307005

03 NOV 1987 23H 46M
SAL 0 30.5
MORO 44.4 0 66.7
SCHO 48.1 0 73.7
SFEO 52.1 0 80.4
ALT
1,78.2,40.0,0.00
1

EPICENTRO NO. 1

PERU, 03 NOV 1987
HORA: 23H46M 13.42S GMT
LATITUD: 11.1058+- 0.0323S 3.5761KM
LONGITUD: 78.2179+- 0.0272W 2.9696KM
PROFUNDI: 85.55+- 5.74KM
MAGNITUD:
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
SAL	67.71	282	142	30.5	17.1	-0.0	0	0.0	0.0	0	
MOR	175.68	312	121	44.4	30.7	0.3	0	66.7	0.1	0	
SCH	205.68	297	119	48.1	35.1	-0.4	0	73.7	-0.4	0	
SFE	229.45	285	118	52.1	38.6	0.1	0	80.4	0.2	0	

RMC= 0.387

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EVENTO # 87308001

[illegible] NOV 1987 03H 10M
[illegible] 65.7 0 86.1
[illegible] 64.1 0 81.4
[illegible] 57.0 0 68.3
[illegible] 55.1
[illegible] 62.9 0 78.3
[illegible] 67.1
[illegible] 73.7
[illegible] 82.3
[illegible] 78.0 0106.9
[illegible]
[illegible] 7.2, 18.8, 0.00

EPICENTRO NO. 1

PERU, 04 NOV 1987
HORA: 3H10M 39.34S GMT
LATITUD: 13.4292+- 0.0306S 3.3865KM
LONGITUD: 77.2212+- 0.0515W 5.5641KM
PROFUNDI: 18.93+- 37.35KM
MAGNITUD:
INTENSID:

STA	DIST	AZM	AIN	P-SEC	TPCAL	P-RES	WT	S-SEC	S-RES	WT	MAG
GUA	166.92	291	114	65.7	26.6	-0.3	0	86.1	0.6	0	
CAM	152.29	190	114	64.1	24.3	0.4	0	81.4	-0.1	0	
PAR	106.47	297	114	57.0	17.1	0.5	0	68.3	-0.7	0	
QUI	100.77	237	114	55.1	16.2	-0.5	0	0.0	0.0	0	
MOR	139.63	188	114	62.9	22.3	1.2	0	78.3	0.3	0	
SCH	178.53	204	114	67.1	28.5	-0.7	0	0.0	0.0	0	
SFE	223.65	209	114	73.7	35.6	-1.2	0	0.0	0.0	0	
JUN	264.54	218	114	82.3	42.0	0.9	0	0.0	0.0	0	
SAL	246.28	170	114	78.0	39.2	-0.5	0	106.9	-0.3	0	

RMC= 0.799

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APPENDIX 3

- List of the DST*-IGP and Computer Center Personnel participating in the AID-CIW/IGP PROJECT for the years 1982–1987.
- DST* Expenditure Estimate for the AID-CIW/IGP PROJECT for the years 1982–1987.
- DST* Expenditure Estimate for the AID-CIW/IGP PROJECT for the 1988 year.

* DST - Dirección de Servicios Técnicos (Technical Services Department)

INSTITUTO GEOFISICO DEL PERU
(GEOPHYSICAL INSTITUTE OF PERU)

LIST OF THE TECHNICAL SERVICES DEPARTMENT AND COMPUTER CENTER PERSONNEL PARTICIPATING IN THE AID-CIW/IGP PROJECT FOR THE YEARS 1982–1987

I.

1.1 Technical Services Department — DST* Division Heads

Names	$ USA	Time %	Years	Total $
Dr. Daniel Huaco	3,000	30	1982–1986	54,000
Ing. Alfredo Bushby	1,800	50	1984–1985	21,600
Ing. Ernesto Deza	2,500	50	Jan 85–May 85	6,250
Ing. Antonio Flores			Jun 86–Dec 86	
Dr. Leonidas Ocola	3,000	70	Jun 87–Sept 87	8,400
Dr. Manuel Chang	2,500	50	Nov 86–1987	17,500

1.2 Geophysical Networks and Electronics Laboratory — DST*

Ing. Antonio Flores	1,500	50	Sept 85–1987	29,400
Ing. Daniel Llamas	1,500	50	1983–1987	45,000
Ing. Tito Frisancho	1,200	60	1983–1987	43,200
Téc. Víctor Montesinos	1,000	60	1983–1987	36,000
Téc. Máximo Galarza	1,000	30	1983–1987	18,000
Téc. Rider Navarro	1,000	40	1983–1987	24,000
Téc. José Velasco	800	30	Sept. 87–Dec. 87	960
Téc. Ricardo Valverde	800	30	Sept. 87–Dec. 87	960
Téc. Manuel Aroni	800	60	1986	5,760
Ing. Rubén Villafani	1,200	100	1984–1985	28,800

1.3 Seismological Service and Projects & Development — DST*

Sra. Matilde Vásquez	1,500	60	1983–1987	54,000
Fís. Leandro Rodríguez	1,500	40	1983–1987	36,000
Sr. Simeón Rodríguez	1,000	50	1983–1987	30,000
Ing. Jhonny Tavera	1,000	50	1986–1987	12,000

*DST — Dirección de Servicios Técnicos (Technical Services Department).

Seismogram Analysis

Sr. Julio Shikiya	1,200	60	1983–1987	43,200
Sr. Melquiadas Damían	1,000	60	1983–1987	36,000
Sr. Francisco Torres	1,000	60	1983–1987	36,000
Sr. Javier Guzmán	1,000	60	1983–1987	36,000
Srta. Ivonne Pérez-Pacheco	800	60	Sept. 87–Dec. 87	1,920
Sr. Luis Neyra	800	60	Sept. 87–Dec. 87	1,920

Seismic Emergency Services

Ing. Efraín Fernández	1,200	100	1983–1987	72,000
Fís. Gloria Marín	1,200	100	1984–1987	57,600
Ing. Ramiro Rosales	1,200	100	1983–1987	72,000
Ing. Vicente Orbegozo	1,200	100	1983–1987	72,000
Ing. Pedro Alvarado	1,200	100	1983–1987	72,000
Ing. Miguel Morales	1,200	100	Jul. 87–Dec. 87	7,200

1.4 Logistics and Administrative Support — DST*

Sr. Edmundo Vila	1,200	40	1983–1987	28,800
Sra. Rosa Osterling	1,000	40	1983–1987	24,000
Sra. Erika Caycho	800	20	Sept. 87–Dec. 87	640
Srta. Yolanda Ramírez	600	20	Sept. 87–Dec. 87	480
Srta. Lidia Jara	600	30	Sept. 87–Dec. 87	720
Sr. Salustiano García	600	100	1983–1987	36,000
Sr. Alfredo Quispe	600	100	1986–1987	36,000
Sr. Fernando Rodríguez	600	100	1986–1987	14,400
Sr. Edgar Ríos	600	40	1983	2,880
Sr. Jaime Aguilar	600	10	1986–1987	1,440
Sr. Carlos Cruces	600	30	1986–1987	4,320
Sr. Porfirio Morales	500	100	1983–1987	30,000
Sr. Humberto Herrera	500	100	1983–Jun 87	27,000
Sr. José Carreño	500	100	1983–1987	30,000

II.

2.1 Computer Center

Ing. Edmundo Norabuena	1,5000	100	1983–1987	90,000
Ing. Luis Mendizabel	1,200	100	1983–1987	72,000
Ing. Henry Salas	1,200	100	1983–1987	72,000
Ing. Rodolfo Alvarez	1,200	30	1983–1987	21,600
				$1,471,950

DST*-IGP EXPENDITURE ESTIMATE FOR THE AID-CIW/IGP PROJECT FOR THE YEARS 1982–1987

Operation, Maintenance, and Data Manipulation. -	
1. DST 1982–1987 Personnel Remuneration	$1,471,950
2. Technical Site - Administrative	36,000
3. Trips and Maintenance	216,000
4. Administrative Expenses	430,988
	$2,154,938

*DST — Dirección de Servicios Técnicos (Technical Services Department)

DST* EXPENDITURE ESTIMATE FOR THE AID-CIW/IGP PROJECT FOR THE YEAR 1988

1. IGP Personnel Remuneration	$320,520
2. Technical Site-Administrative	6,000
3. Trips and Maintenance	36,000
4. Administrative Expenses	115,630
5. Acquisition of Goods and Services and Capital Goods	100,000
	$578,150

*DST — Dirección de Servicios Técnicos (Technical Services Department)

SYSTEM ASSESSMENT
(January 1987)

Edmundo O. Norabuena

Instituto Geofisical del Peru
Apartado 3747 - Lima 100
Peru

Introduction :

The Autoseis seismic analysis system begun his operation on July 1983 at the Central Laboratory of IGP. One of the purposes of this system was to serve as an early warning system of significative events detected by the telemetered network in wich case the information is transmitted to the Civil Defense System for the appropiate actions. Other goal of this system is to record and archive seismic information in order to build a database and give scientist a source of data for his investigations.

The system is composed by a Prime 250-II minicomputer, with 1 MB of RAM memory and 300 MB storage disk. Due to the time sharing feature, five processes process concurrently the incoming data in order to detect the occurrence of a seismic event and its location.

Operation :

The basic operation of the system is in hands of five seismic-Analysts. These, work in shifts covering 24 hours of continuous operation. After the preliminar report of the Autoseis system, this analysts using a graphic terminal, verify the p and s lectures making the appropiate changes in order to get a good location for the quake.

During July 1983 and December 1986 , the Autoseis has processed and archived 2257 events with an average of 54 per month. This events are archived in 31 tapes with a gross volume of 953 MBytes(0.7 factor) giving an average of 22.7 Mbytes per month.
See appendixes A and B.

The operation of the system has been continuous except for interrupts due to preventive and corrective maintenance and some major times due to blackouts. The longest system downtimes has been due to line conditioner (Dec 84), Disk controller (Ag.85), R/W heads of the 300 Mb. (Set - Oct 85) and the Belt between motor and spindle (Dec 86).

See appendix C.

Problems :

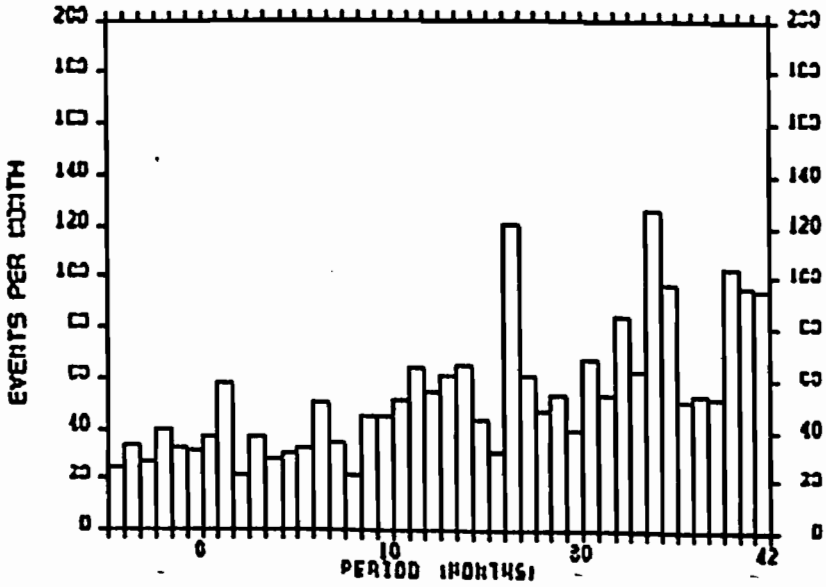
- Since the beginning we have had trouble with computer maintenance due to the weak local support of Prime's representatives.
- Lack of technicall information on Prime systems due Prime's policy with customers.
- Lack of basic spares for critical equipment as printers and disk.
- Lack of appropiate maintenance tools for promptly fault diagnosis.

In spite of the mentioned problems, we have fixed the computer and associated peripherals. Sometimes this has been possible due to the prompt help of Carnegie, sending us the solicited spares.

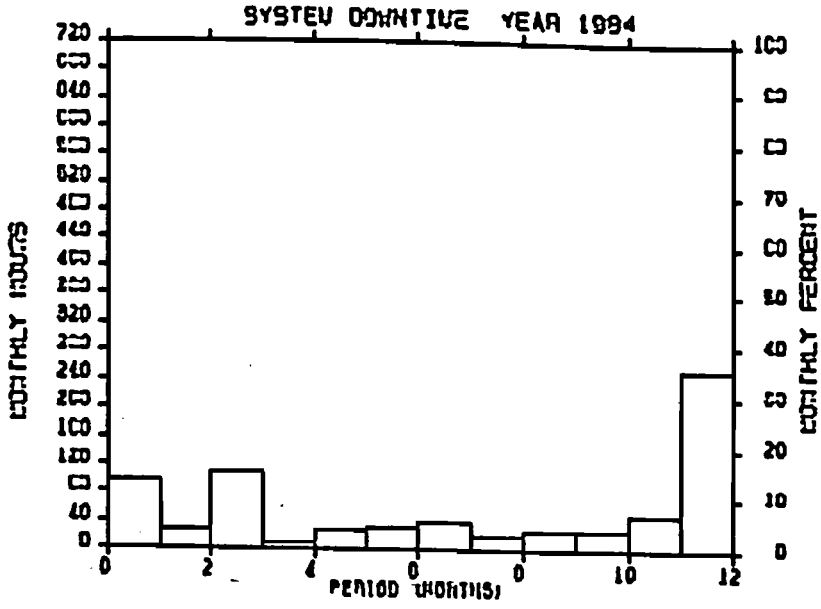
Appendix A : Event Statistics

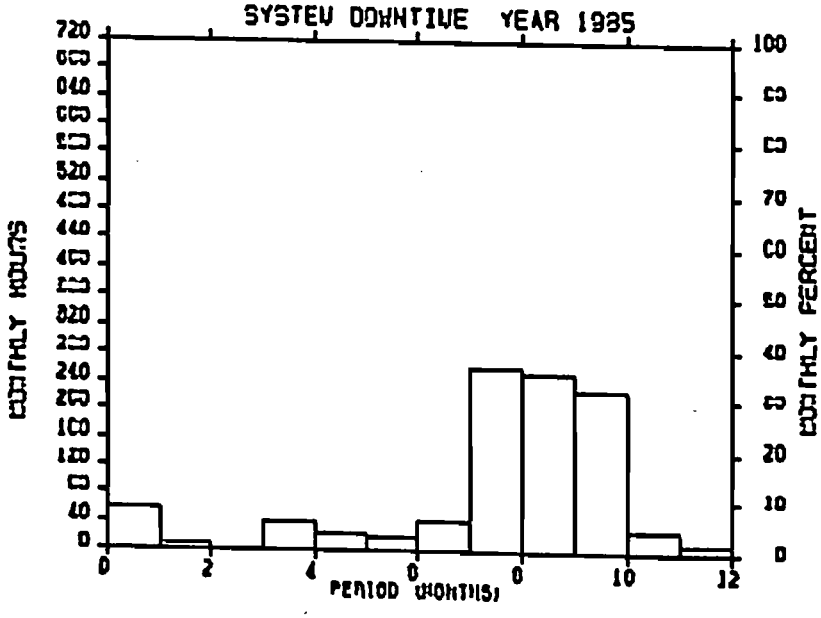
Month	1983	1984	1985	1986	1987
January		36	51	67	
February		58	64	54	
March		21	55	84	
April		36	61	63	
May		28	65	126	
Jun		30	44	97	
July	25	32	31	51	
August	33	50	121	53	
September	27	34	61	52	
October	40	21	47	104	
November	32	45	54	96	
December	31	45	40	95	
T o t a l	188	433	694	942	
Total 1983-86					2257

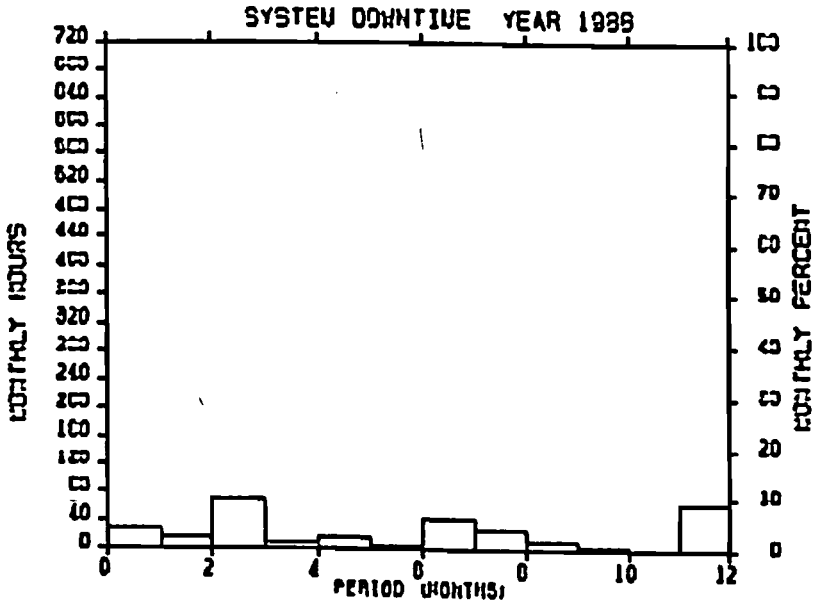
APPENDIX B - EVENTS FROM JULY 83 TO DECEMBER 86



APPENDIX C - SYSTEM DOWNTIMES






SYSTEM DOWNTIME YEAR 1988
MONTHLY HOURS
MONTHLY PERCENT
PERIOD (MONTHS)
0
2
4
6
8
10
12

APPENDIX C.1 - SYSTEM DOWNTIMES

MONTH	1983	1984	1985	1986	1987
JANUARY		97.7	57.0	27.0	
FEBRUARY		26.1	7.3	16.3	
MARCH		107.8	0.0	70.3	
APRIL		8.4	41.0	7.2	
MAY		29.0	22.7	16.0	
JUNE		32.1	22.0	5.3	
JULY		38.2	42.0	44.5	
AUGUST		18.8	262.0	28.0	
SEPTEMBER		29.1	253.0	10.8	
OCTOBER		26.9	230.0	5.7	
NOVEMBER		48.7	30.0	3.0	
DECEMBER		255.0	13.0	66.0	
T O T A L		718.3	980.0	296.4	
YEAR PERCENT (8760 AVAILABLE HOURS)		8.2	11.2	3.4	

REPORT ON PRIME TRAINING COURSE

Introduction:

Thanks to a Carnegie Institution of Washington invitation, I could assist to the Prime Educational Center at Milford, Massachussets. The period was March 23-April 10. The purpose of this trip was to acquiere a better knowledge of Prime system's hardware in order to support and upgrade the Autoseis system of the CIW-AID-IGP project. This will let us to improve the Autoseis from the Prime 250-II to the 2655 model. The advantages of this new system will be described in a next report.

Description of Courses:

During the three weeks of training we attended the following courses:

a) Series 2000 Course (March 23 - 27)

This course covered the 2350,2450 and 2655 Prime systems and associated peripherals. During the five days that this course lasted, the following topics were developed:

- Systems description and Configuration.
- Hardware configuration options.
- System installation and cabling.
- Overview of Primos Rev. 20 features.
- Study of the virtual control panel model 4 (VCP4).
- Suggested maintenance and troubleshooting.

b) Winchester Disks Course (March 30 - April 7)

This course covered two different models of Winchester disks. The first one was the AMS 315 Advance Marksman Series of 300 MB and the second the Control Data 675 MB. The course covered operation, maintenance and troubleshooting of these units.

c) Printers Course (April 8 - April 10)

This course covered mainly the Dataproducts 300 and 600 LPM printers, but we obtained technical information and documentation of the Printronix 300 printer, as we have with the Autoseis system.

All classes were hold from Mondays to Fridays between 09:00-12:00 and 13:00-16:30 Hrs.

Summary and Suggestions :

The experience gained with Prime systems will let us give the Autoseis seismic detection system an accurate and oportune maintenance avoiding system downtimes and higher costs of external maintenance. This acquiered knowledge will also let us improve the perfomance of the Autoseis both hardware and software modules, specially those concerning the operating system internals.

Since most of the delays in fixing computer problems is due to the lack of appropiate tools and/or spares in local markets, I would like to suggest, if possible, that Carnegie Institution of Washington DTM, continue helping us in this field.

Although we have gained experience with the Prime system, I want to remark the necessity of pressing Prime Computer Co. at a higher level in order to give CIW/IGP a preferential treatment. This will facilitate the transfer of technical information as needed by CIW/IGP research activities with Prime systems.

Acknowledgements :

I want to thank Dr. Selwyn Sacks, principal investigator of the AID/CIW/IGP project, for his permanent interest in giving us all the necessary tools in order to support the Autoseis system.
I also want to thank Dr. Sacks for his invitation to visit Carnegie Institution of Washington, because this let me to met Dr. John Schneider from whom I received information of how to use the Joint Hypocenter Location Program (JHD) in order to adapt it at IGP. During this visit I also reviewed some papers and did a simulation on calibration pulses over a SS1 seismometer in order to finish a final report on systems response for the PDR1's and telemetered networks.

Edmundo O. Norabuena
Instituto Geofisico del Peru

Lima 30 de Abril de 1987

Lima, 10 de marzo de 1987

Dr.
José C. Pomalaza Díaz
Presidente Ejecutivo
Instituto Geofísico del Perú
Presente

Ref.: Donación Equipo Red Sísmica AID-CIW/IGP

Me es grato de informar a Ud. que en cumplimiento del artículo 6 del "Convenio de Cooperación Técnica entre el Instituto Geofísico del Perú y la Institución Carnegie de Washington/AID" el Departmento de Magnetismo Terrestre de la Institución Carnegie de Washington (DTM-CIW) confirma la donación al IGP de equipo sismológico, extensométrico y equiupo del Centro de Procesamiento de Señales Sísmicas en Tiempo Real de la Red Sísmica AID-CIW/IGP de acuerdo a las guías aéreas siguientes (Anexos 1-13):

G. Aérea No.	042-35227625	- 12 btos.	Computadoras y pre-procesador
G. Aérea No.	044-22437822	- 01 bto.	Cintas magnéticas
G. Aérea No.	044-23227842	- 04 btos.	Equipos sísmicos y radiotelemetría.
G. Aérea No.	042-37394840	- 01 bto.	Estabilizador de voltaje.
G. Aérea No.	044-22437881	- 05 btos.	Equipos sísmicos y radiotelemetría.
G. Aérea No.	045-08046076	- 01 bto.	Partes-repuestos electrónicos.
G. Aérea No.	042-39597025	- 01 bto.	Partes y repuestos electrónicos.
G. Aérea No.	042-38598022	- 01 bto.	Cintas magnéticas.
G. Aérea No.	042-39606921	- 01 bto.	Cintas magnéticas.
G. Aérea No.	1390586	- 04 btos.	Grabadoras Kennedy
G. Aérea No.	044-23590582	- 01 bto.	Partes de repuestos.

G. Aèrea No. Papeleta4634 - 01 bto. Partes.
G. Aèrea No. 045-08799711 - 61 btos. Equipos extensomètricos.

Muy atentamente,

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