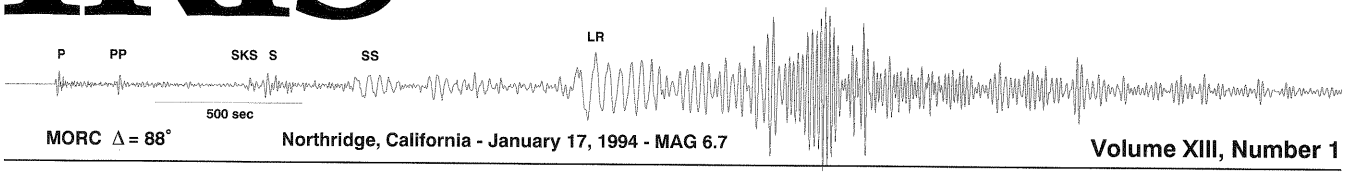
IRIS Newsletter



MORC Δ = 88° Northridge, California - January 17, 1994 - MAG 6.7 Volume XIII, Number 1

The GEOFON Program

Winfried Hanka and Rainer Kind, GeoForschungsZentrum Potsdam, Germany

Broadband seismology has a long tradition in Germany. The Gräfenberg array (GRF), located in Northern Bavaria and operated jointly by the Federal Institute for Geosciences and Natural Resources (BGR) and the German Science Foundation (DFG), was the world's first major digital broadband installation. It has been operational since 1976 and many scientific studies, carried out with its high quality data, demonstrated the benefit of broadband digital recording (e.g. Buttkus et al., 1986). Between 1991 and 1993, 12 stations of the German Regional Seismic Network (GRSN) were installed by the BGR and DFG as an extension of the GRF array to regional distances (Hanka,1991).

Following that tradition, the GeoForschungsZentrum (GFZ) at Potsdam, an institution for interdisciplinary research in geosciences, founded in 1992 by the Federal Ministry of Research and Technology, has started a program for the establishment of a network of globally distributed broadband seismic stations. The program, GEOFON (GEOFOrschungs-Netz), is dedicated to Ernst von Rebeur-Paschwitz who recorded the first teleseismic seismogram 1889 in Potsdam and proposed a global seismograph network and an earthquake reporting system (von Rebeur-Paschwitz, 1895 a,b). Our program will, after its completion, consist of three parts: a permanent network of about 30 stations, a portable broadband network and a comprehensive data archive. It is planned for two three-year periods (1993-1995 and 1996-1998). The funding for the first period has already been provided almost completely. An Advisory Board with members from German Universities and the GFZ guides the operation of GEOFON.

The main task of the program is to serve the seismological community with high quality broadband data for all kinds of scientific tasks. The research projects at the GFZ itself, to be carried out with GEOFON and other broadband data, are presently dealing mainly with lithospheric and upper and lower mantle 3-D structure.

The Permanent Seismic Network

The permanent GEOFON network has two major goals: one is to fill at least some gaps in the global VBB network in cooperation and coordination with other member networks from the Federation of Digital Seismograph Networks

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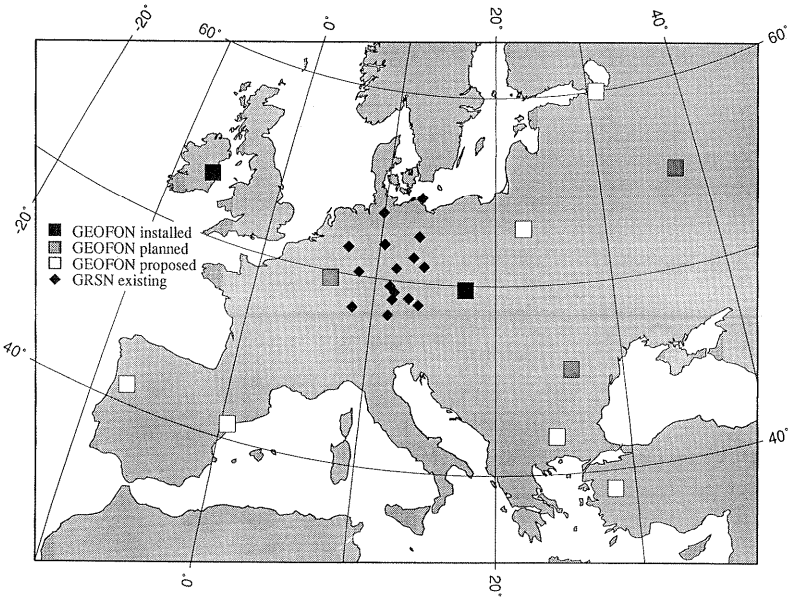

Figure 1: GEOFON and GRSN station distribution in Europe.

What's Inside

Continued from page 1

(FDSN). The other important task is the densification of the FDSN network for high resolution regional studies of seismicity and earth structure by upgrading existing seismological observatories with modern broadband equipment in certain areas. In the first phase, this part of the program focuses on stations in Europe, especially eastern Europe, but also some parts of western Europe.

The present GEOFON siting plan is shown in Figures 1 and 2. Two GEOFON stations equipped with STS-2 seismometers were installed in 1993: MORC in Northern Moravia (Czech Republic) in cooperation with the Masaryk University Brno and DSB near Dublin (Ireland) with the Dublin Institute for Advanced Studies. More stations are to be installed in the first half of 1994 in Walferdange (WLF, Luxembourg), Muntele Rosu (MLR, Romania) and Michnevo (near Moscow, Russia). Other planned stations are presently Nord (Northern Greenland) and Sanae (Antarctica) in cooperation with the Alfred-Wegener-Institute for Polar Research in Bremerhaven (AWI), Tashkent (Uzbekistan) and Yogyakarta (Indonesia). Proposals for additional sites on Iceland, the Iberian Peninsula, St. Petersburg (Russia), NE Poland or Lithuania, Bulgaria, Turkey, Kirgizstan and Chile are being discussed presently by the Advisory Board.

Joint Stations with IRIS GSN

For the installation and operation of some global stations of the FDSN network, a comprehensive cooperation between the GFZ and IRIS/USGS was established in 1993. Under this agreement, the deployment of five joint stations in different parts of the world is planned: Port Moresby (New Guinea) (PMG, installed in September 1993), Antofagasta (Chile), Nairobi (Kenya), Ny Alesund (Spitsbergen) and Sondre Stromford (Greenland). At two of these sites, a third partner has joined the bilateral cooperation: POSEIDON at PMG and the AWI in Spitsbergen. One special benefit to the GEOFON program from cooperation with IRIS/USGS is access to the comprehensive knowledge of the Albuquerque Seismological Laboratory in installation and long-term operation of global seismological networks.

The Station Hardware

Depending on the different tasks, two different station types are used for permanent installations: the GRSN- and FDSN-type systems. Since they represent the defacto standard in VBB seismology, in both cases Quanterra systems were chosen as the basic data logger. The FDSN-type systems, because all of them planned for the first phase of the program are joint stations with IRIS-ASL, are orientated to IRIS standards. They are equipped with STS-1 sensors and IRIS-2 data loggers, separated in a 9-channel Quanterra data acquisition (DA) unit and a station data processor (DP) with 400 MB disk space and two 150 MB QIC cartridge tape drives with an intra-site communication link in between. In some sites the compact version of the IRIS-2 data logger is or will be used.

The GRSN-type systems for more regional purposes consist of a STS-2 VBB seismometer and a compact Q380/LT-G data logger equipped with three 24 bit 80 sps digitizers, a 68030 CPU board with 4 MB memory, 200 MB internal disk, a 150 MB QIC magnetic streamer, 4 serial ports and an external SCSI connector. In some cases, six-channel Q680 systems will be used to operate additional strong motion sensors. Three different data streams (20, 1 and 0.1 sps) are stored continuously and one on a triggered basis (80 sps). The STS-2 sensors are additionally shielded against long period temperature and pressure variations as well as corrosion using a specially designed aluminium casing with a 5 cm thick base plate. With this shielding, the long period resolution of the STS-2 is improved substantially and comes for most purposes close to the STS-1 sensors. Both stations types are completed with high speed dial-up modems, graphical displays and laser printers and uninterruptable 24 VDC power supplies. Timing is performed normally by a GPS time receiver.

Temporary Deployment of Broadband Stations

The GFZ is also establishing a pool of seismic stations for active and passive

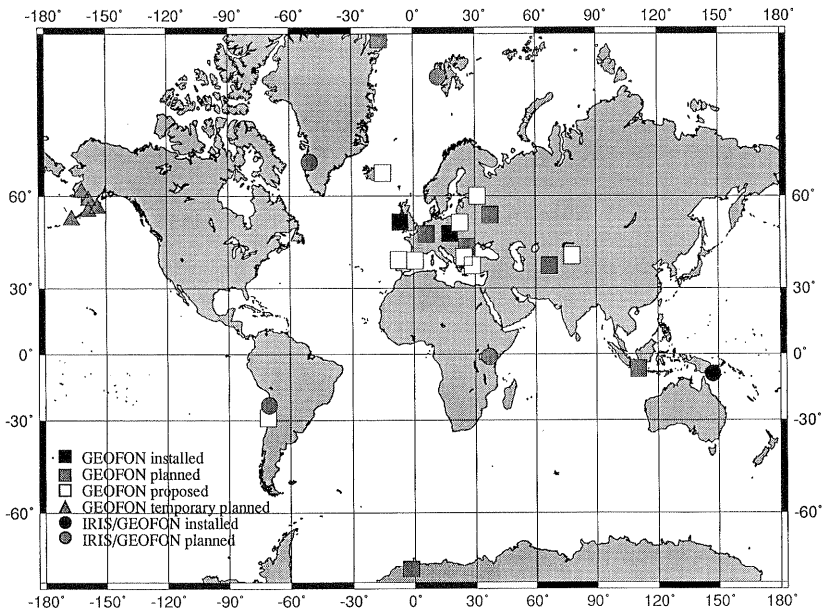

Figure 2: Global GEOFON station distribution.

experiments, comparable to the IRIS-PASSCAL program. At present, this pool consists of about 130 PDAS and REFTEK data loggers and a set of sensors including 12 GURALP CMG3-T broadband instruments. The GEOFON program is responsible for the broadband part of this pool.

The first project of this kind has already been started: a passive seismic tomography experiment carried out between January and May 1994 in the Atacama Basin, east of Antofagasta (Northern Chile) by the GFZ and Free University of Berlin. Here a total of about 25 mobile stations including four BB stations equipped with STS-2 sensors and PDAS 100 data loggers are distributed over an area of 100 by 50 km. Four mobile stations equipped with Guralp CMG3-T sensors several hundreds of km north and south of the investigated area and a semi- permanent GEOFON station installed near Antofagasta as reference stations, complete this experiment. The installation of the GEOFON station has also another goal: to investigate noise and other conditions for the planned GEOFON-IRIS station at a new site near Antofagasta.

A second longer term project takes place in the Eastern Aleutian Island and Western Alaskan Peninsula, where five stations will be installed for about two years in cooperation with the University of Alaska in Fairbanks to study the subducting Pacific plate and the seismicity in and around the Shumigan Islands. Three complete GEOFON stations have already been shipped to Alaska for test installations and the whole set should be installed in the final locations by early summer of 1994.

The next temporary operations including broadband sensors will be: a study in Tibet in the second half of 1994 (a cooperative project with PASSCAL) to investigate the lithospheric structure; a deployment in Denmark and Southern Sweden in early 1995 to study the Tornquist-Tesseyre Line; and a larger experiment in the Carpathians also in 1995.

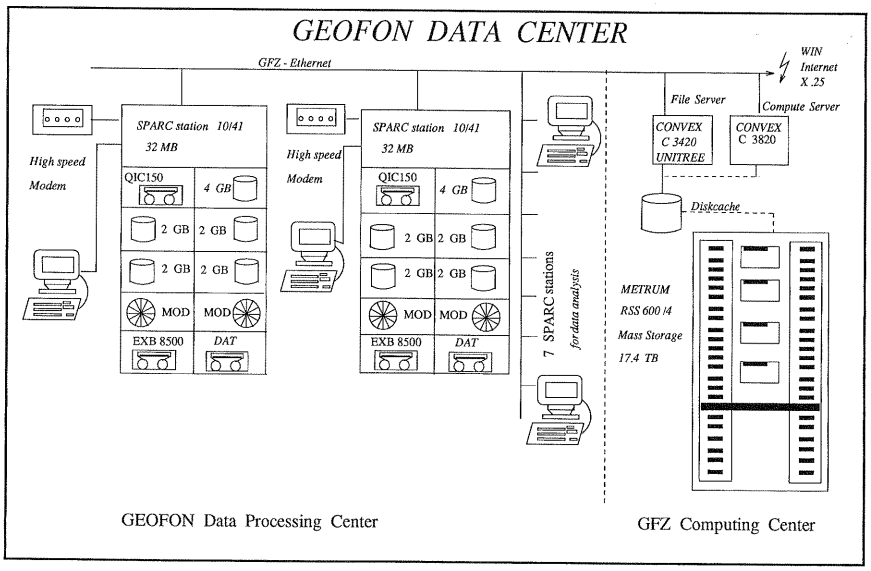

Figure 3: Computer hardware of GEOFON Data Center at the GFZ Potsdam.

The GEOFON Data Center

As part of the bilateral cooperation between IRIS and GEOFON, the IRIS DMC helped to install data communication and archival software at the Potsdam GEOFON data center. The IRIS GOPHER system is now used to automatically access the GEOFON stations after major events to retrieve selected event data. The DIRTS data base system was installed to manage the archival of the mass station data received at Potsdam on magnetic cartridges. As can be seen from Figure 3, the data collection and processing of the data of the GEOFON and other stations is handled mainly on a set of two SUN 10/41 server systems with high disk capacity (more then 20 GB) and all necessary peripheral devices. As the main mass storage unit, a 18 TB METRUM RSS600/4 system with UNITREE archival software is available at the GFZ Computing Center through a CONVEX file server system.

The GEOFON Online Data Pool

Triggered by the NEIS automatic alert messages, or other more regional sources like EMSC or the GERESS alert system, automatic data retrieval is performed for all GEOFON stations accessible by phone lines. If possible, local Internet nodes in host institutes are used as sub-nodes in the GEOFON GOPHER system. In addition, a similar system based on X.25 communications was developed, which provides data from other German stations like the GRSN stations and the GRF and GERESS arrays. Since the GEOFON GOPHER system is one node in the global GOPHER system, direct access to data retrieved by the other GOPHER nodes like those at the IRIS DMC at Seattle or ORFEUS in Utrecht is available over Internet. Therefore, several hours after an event has occurred, high quality broadband data from all available sources are collected in the online data pool in Potsdam and available to the seismological community. The data can be accessed through the well known gopher-view user interface using the GOPHER or DRM data request manager accounts (passwords geofon) via Internet on st8.gfz-potsdam.de, via X.25 (262-45050231902) or via modem (+49-331-288-1693 to 1696).

The GEOFON Data Archive

Assembled data sets to be stored in the GEOFON data archive are received through a number of different sources. Beside the actual SEED data sets of all

Continued on page 4

Job Opening

Research Engineer/Staff Associate

Provide technical support for PASSCAL portable seismic instrument program. Duties include: coordination of experiment support, training of personnel in operation of equipment, experiment support including in-field effort, maintenance and calibration of equipment, and development of equipment and procedures. Equipment includes seismometers, data recorders, power supplies, portable computer/control units, and data processing computer systems (SUN workstations).

Emphasis is on a person with well rounded experience who: has an interest in the Earth Sciences, particularly seismology, must be prepared to travel for field testing and support, must be able to interact within a small team of programmers, engineers, and scientists to achieve the goals of the PASSCAL program, must have a good command of written and spoken English.

BS in an appropriate field with minimum of two years experience. Experience in seismic research area particularly useful.

Reply to: Personnel Department, Lamont-Doherty Earth Observatory, P.O. Box 1000, Palisades, NY 10964, fax: (914) 359- 2931 •

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GSN Update

IRIS/ASL has upgraded the Graefenburg, Germany (GRFO) Seismic Research Observatory (SRO) site in collaboration with the Bundesanstalt fur Geowissenschaften und Rohstaffe (Geological Survey) of Germany. Site equipment includes a KS36000i broadband borehole seismometer and a 24-bit Quanterra data acquisition system.

IRIS/IDA has installed a new 24-bit IRIS-3 data acquisition system and STS-1 seismometers at Hobart, Tasmania, Australia (TAU), replacing the old DWWSSN system. The USGS has completed a new GTSN site at Dry Valley (VNDA), Antarctica. •

Continued from page 3

original GEOFON stations and associated stations (assembled directly in Potsdam), data sets from the joint IRIS-GEOFON stations (compiled at the IRIS/ASL DCC in Albuquerque), from the German broadband stations (assembled at the German Central Seismological Observatory in Erlangen) and also data sets of selected stations from other networks (e.g. IRIS, GEOSCOPE or MedNet) will be stored in the GEOFON data archive using the DIRTS data base system. These data are freely accessible for the seismological community through the DRM account (see above) using the known IRIS developed user interfaces: by e-mail (BREQ_FAST and RUMBLE), SQL data base interface (SPROUT) and X-tools (XRETREIVE and XTRACT) (see also Figure 4).

The content of the data archive is still quite small at the present time, since the first IRIS-GEOFON station PMG started operation in September 1993 and the GEOFON stations MORC and DSB in November and December 1993, respectively. But this situation will improve soon because more GEOFON and IRIS- GEOFON stations will shortly become operational and data of the GRF array (starting from 1976) and of the GRSN network (beginning in 1991), which were already copied from the original data media into the METRUM system, will be translated into full SEED volumes in a major effort during the next months and integrated into the GEOFON data archive and the DIRTS data base. The GEOFON data archive will then provide a new source of high quality broadband data to the seismological community. GEOFON data will also be available through the IRIS DMC and the ORFEUS Data Center. •

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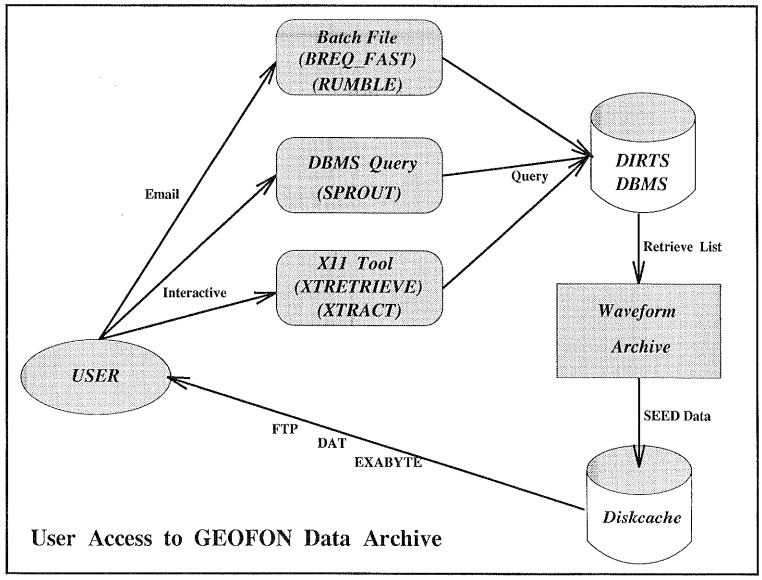

Figure 4: User data retrieval from the GEOFON Data Archive in Potsdam.

The Moscow IRIS Data Analysis Center

Mikhail Rozhkov, Moscow Data Center and Tim Ahern, IRIS Data Management System

The Moscow IRIS Data Analysis Center (MDC) has a rather short history. It was created in 1991 by the cooperative efforts of the IRIS Consortium, the Academy of Sciences of the Soviet Union and the SYNAPSE Science Center. At the present time the MDC is run by SYNAPSE with the financial and software support of the IRIS Data Management System. For this reason sometimes the MDC is referred to as MDC/SYNAPSE. SYNAPSE is a private Russian corporation through which the MDC receives organizational and financial support in addition to the support provided by IRIS.

Since its creation, the MDC started to serve as an informational and computational node for scientists from the Former Soviet Union (FSU), working in the area of seismology and geophysics. Scientists from the Academy of Sciences of Russia have access to the MDC facilities not only just at the Center, but also by using dial-up telephone lines that can support TCP/IP protocol. A dedicated telephone channel to the Obninsk National Data Center provides access to the Internet using a dedicated IRIS circuit through a satellite antenna installed at Obninsk. Almost all facilities of the IRIS DMC in Seattle are accessible from the MDC. We expect that very soon (by the summer) the MDC will begin to serve as a node of the Russian Electronic Academic Network (RELARN), based on the Russian RELCOM public network infrastructure and fiber-optic backbone, laid in Moscow and connected to more than twenty Academic Institutes. It would open additional high-speed channels to the Internet. Presently the MDC is equipped with facilities which allow mail traffic between the dedicated IRIS communications line, and the Russian public electronic networks. This significantly enhances the communications and connectivity of the MDC to the Internet community.

The MDC is involved in many different domestic and international projects. Among the domestic projects are projects with the Academy of Sciences and its institutions, Ministry of Sciences and some other governmental offices. The State Committee on Extraordinary Situations recently formed the Federal System of Seismological Observations and Earthquake Prediction (FSOEPS). It is anticipated that the MDC will occupy the same position within FSOEPS as the IRIS DMC does within the US seismological community. There are also a number of foreign partners of the MDC, like Bullard Laboratory of the University of Cambridge (UK), Lawrence Livermore National Laboratory, Shell Research B.V., but the principal partner remains the IRIS Data Management System. The DMS supplies the MDC with necessary documentation on operating systems and network facilities, and on available seismic software, which is in use in most of the American Universities. In return, MDC staff develop software for the IRIS DMS. Presently, a CDROM reading utility for decoding information on the CDROM containing the ISC hypocenter information is being beta tested at the DMC. The IRIS DMS also upgraded the MDC computing facility. A Sparcstation-2, SUN-4/330, new disc drives, modems and other facilities were delivered by the DMS during the previous year. We anticipate continuing cooperation between the IRIS DMS and the MDC in the future.

Figure 1. A map of the six stations that have been installed as part of the Caspian Sea project.

The MDC staff consists now of ten persons, operating the Center and performing research. The members of the MDC are:

- Katya Fomina - MDC secretary
- Vladimir Gurevich - system manager and programmer
- Leonid Hykin - researcher
- Eugeny Kapitchnikov - engineer
- Vasily Kiselevich - programmer and researcher
- Alexander Kushnir - researcher
- Andrey Rasskazov - system engineer and researcher
- Mikhail Rozhkov - researcher and director
- Andrey Shaboha - programmer
- Boris Shubik - researcher

At present, the MDC is involved in several research projects. The following paragraphs highlight just a few of them.

Caspian Sea Project

Together with Bullard Laboratory (Principal Investigators are Dr. Keith Priestley, Bullard, and Dr. Mikhail Rozhkov, MDC), and with the help of the Institute of Seismology of Turkmenistan (Dr.Batyr Karryev) and Geophysical Expedition

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of Azerbaijan (Dr. Spartak Agamirzoev), MDC/SYNAPSE has installed an array of broadband digital seismographs (REFTEK data loggers and Guralp CMG-3T) on both sides (Turkmenian and Azerbaijanian) of the Caspian Sea (see Figure 1). It is intended that these recorders operate about 2 years. The project has been started to better understand the seismic structure of the south Caspian Basin and the surrounding region. There are two goals of this experiment: (1) to better define the complex crust and upper mantle structure in this area; and (2) to better understand regional seismic wave propagation in the region. Kyzyl-Atrek (KAT) station, Nebit-Dag (NBD), Dana-Ata (DTA) and Krasnovodsk (KRV) in Turkmenia, and Nardaran near Baku (BAK), and Balabur near Lenkoran (LNK) operate now in continuous mode (10 samples per second), and will soon also operate in a triggered (100 sps) mode. By recording the data in such a manner, we can look at the seismic structure of the Caspian using a variety of techniques. For example, the teleseismic body-wave recordings will allow us to determine the receiver function at each of the sites, which can be inverted for crustal structure beneath the receiver site. The existence of the hypothesized "oceanic" crust beneath the Turkmenian lowlands to the east of the south Caspian Basin should provide large converted phases, which will be easy to distinguish in the receiver function signal. Continuous data recording will allow us to also record teleseismic S-waves and surface waves which are more difficult to record when operating data loggers in the triggered mode. We will be able to measure shear wave splitting which can be used to determine mantle anisotropy. The seismograph pairs are laid out in such a manner that we will be able to measure two station phase velocities for several great circle paths crossing the Caspian Basin and use these results to determine the average crust and upper mantle shear wave structure of the region. The abundant regional seismicity will allow us to measure higher frequency single station phase velocities for many paths crossing the south Caspian Basin and potentially determine the three dimensional variation in the crustal structure. In this experiment SYNAPSE provides station installation and maintenance, data collection and preprocessing. Bullard Laboratory provides scientific and technical supervision as well as performing significant data processing.

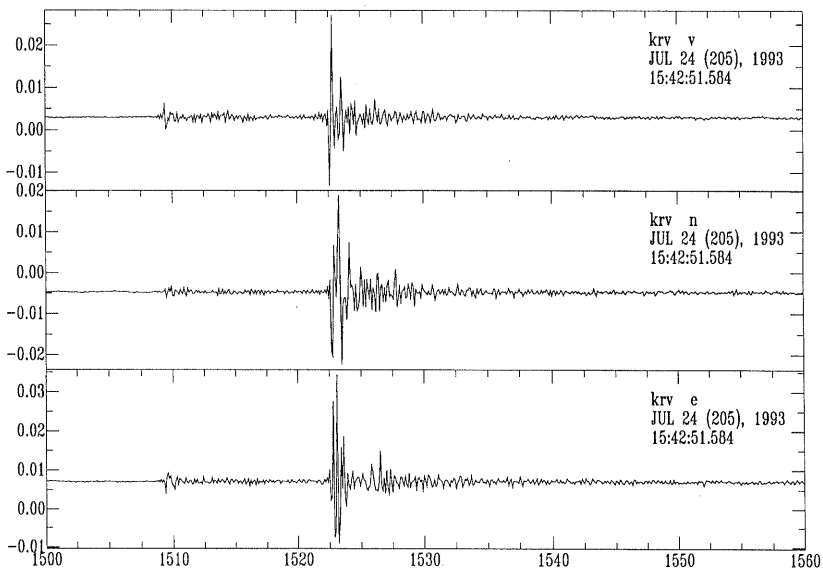


Figure 2. A local event recorded on three components at the Krasnovodsk (KRV) station. The very high signal to noise ratio is evident.

Historical Seismograms

Another project is being performed now together with Dr. Sergey Zverev's laboratory of the Institute of Physics of the Earth (IPE), and partially financed by the Russian Fund for Basic Research. This is the creation of the archive and database of the Deep Seismic Sounding (DSS) experiments, conducted by IPE during the last 30 years. The technique of DSS for continental studies was widely used in the USSR, but the marine DSS research of the Earth's crust and upper mantle were carried out mainly by IPE. As a source, strong underwater explosions were used. Since 1970, ocean bottom stations have replaced hydrophones and seismographs installed from research ships and submarines in the sixties. The success of the experiment was aided by participation of Soviet war ships, conducting explosive work for the profiles. For the near shore experiments, marine observations were accompanied by land observations. Huge archives of paper records and analog magnetic tapes were collected during the following experiments:

- Caspian Sea (1956, 2500 km profile);
- Okhotsk Sea (1957, 4800 km);
- Pacific (1958, 3700 km; 1967, 2200 km)
- Barents Sea(1958, 300 km; 1976 and 1982, 1500 km);
- Japan Sea (1958, 300 km; 1963, 2600 km);
- Northern Atlantic-Island region (1972 and 1977, 2500 km);
- Southern Atlantic - Angola-Brazilian Geotraverse (1980-1986, 5500 km);
- Eastern Mediterranean - Cyprus (1987-1990, 1200 km).

Initially all data from two experiments will be processed, the Southern Atlantic and the Eastern Mediterranean. The job includes digitizing of paper records, converting data from analog magnetic tapes into "normal" seismic format, development of the database structure and filling the database with the information of the experimental conditions, original and processed data, etc. An archive of scanned images will be created as well. The scanning system, including a PC and Houston Instrument scanner of A0 format, was delivered earlier by Dr. Holly Given, IRIS/IDA as part of the IRIS/JSP Histroical Seismogram Project. The software for digitizing scanned images on SUN workstation was developed by MDC programmers and tested on a wide variety of signals, mainly on DSS records

(Andrey Petrov, Leonid Hykin, Mikhail Rozhkov).

The program provides automatic, semiautomatic and manual digitizing, trace editing, time correction, converting files into CSS-2.8 format, and some other features.

Small aperture array monitoring system

This project is being performed in close cooperation with NORSAR NTNF. During the past several years Professor Alexander Kushnir has conducted research in the area of multichannel adaptive processing for small aperture seismic arrays. Since 1992 he has lead the development of advanced techniques for regional seismic monitoring in areas affected by strong seismic noise. This project primarily uses data from seismic installations in coastal areas. Since these observational sites are affected by strong seismic noise generated by sea waves, it makes it difficult to process signals from weak seismic events using conventional methods and provide reliable event location and detection for regional seismic events. As part of this study, a Problem Oriented Programming Shell (POPS) for SUN workstations was developed for running the data processing procedures in batch and interactive modes. The goal of the system is to determine seismic event locations, in near real time, using data from a single small aperture array. The POPS consists of an on-line broad band Adaptive Detector (AD) and a multiuser Event Processor (EP). The AD subsystem provides the means to run the programs for on-line seismic signal detection, and periodic system adaptation for the current array noise. The EP subsystem provides the tool to perform the sequence of event processing procedures in both interactive and batch multiuser modes. The algorithms can properly estimate an arrival direction of a weak seismic phase in a background of interfering waves, for example, coherent coda of a previous strong wave phase. The usefulness of the developed algorithms have been proved by simulation studies and by testing on data from the small aperture Scandinavian arrays NORESS, ARCESS and FINESA. The system was successfully demonstrated and tested at NORSAR in January-February, 1994.

Other Significant MDC Projects

In the future we will write additional articles for the IRIS newsletter highlighting other significant MDC/SYNAPSE projects such as ASET (Array Seismic Emission Tomography); SPAK, a lossless data compression package; SONOPLUS, a neural net based sonogram analyzer; and some additional projects.

The MDC/SYNAPSE also organizes scientific seminars with high attendance from several Russian institutions, and three years ago established a college specializing in data processing with application to a variety of fields including Earth sciences. The Moscow Data Center can be reached on e-mail as rozhkov@iris.washington.edu. •

We wish to acknowledge the contributions of Dr. K. Priestley, Dr. A. Kushnir, and Dr. S. Zverev to this article.

New Assembled Data Sets at the IRIS DMC

During the past few months several new data sets have become available at the IRIS DMC. These include:

From the JSP Center in Boulder, Colorado.

- Eurasian Tomography Information Product

  Contains long period waveform and parameter data from 105 events in and around Eurasia from 1989-1992. The data sources are the IRIS DMC and the GEOSCOPE CDROMs.

- Kyrgyz Information Product

  Contains data and information from the Kyrgyz Telemetered Network (see IRIS Newsletter XI, 1, Spring 1992) for events from triggered channels between September 1991 and August of 1992.

- Central Asian Bulletin

  Contains a complete bulletin and catalog of 1186 events using data from IRIS/GSN, Kyrgyz Telemetered Network, CDSN and GEOSCOPE networks. The bulletin is for the month of May 1992.

From the PASSCAL program we have received three data sets during the past several months.

- Tibetan Plateau

  This data set is from Francis Wu and Tom Owens' deployment of 11 PASSCAL instruments with broad band sensors in Tibet from July 1991 through June 1992.

- Virginia EDGE Experiment

  This data set contains a seismic reflection survey recorded by both offshore OBS recording systems as well as PASSCAL instruments on land. This experiment was conducted by S. Smithson and B. Carr at the University of Wyoming.

- BASIC - Beaufort Ambient Seismo-Acoustic Beneath Ice Cover

  This data set comes from part of an ONR sponsored study of noise propagation under an ice sheet. The data was collected by Adam Schultz and Brian Lewis at the University of Washington. It was collected in 1990.

More complete information can be obtained by accessing the IRIS DMC Electronic Bulletin Board:

rlogin dmc.iris.washington.edu

Login as userid bulletin and password board. Once in the main menu of the bulletin board select the *"a"* option to view assembled data set holdings and then select the *"j"* for JSP Center Information products or *"p"* to view the PASSCAL data sets available for distribution. •

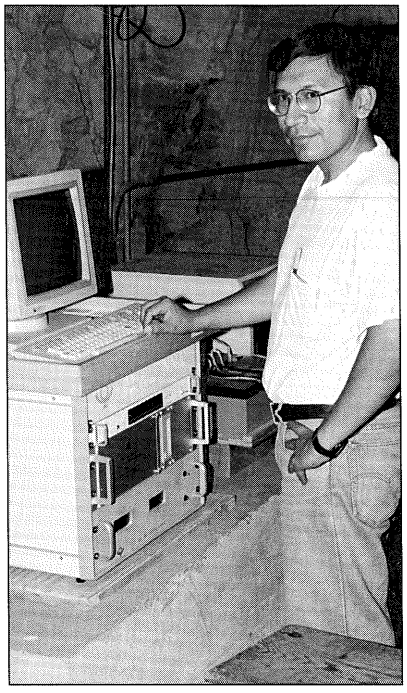
Tim Ahern, DMS Program Manager

NNA: A Brief History of the Seismographic Station at Naña, Peru

Edmundo Norabuena, Seismic Processing Center, Geophysical Institute of Peru
Holly Given, Project IDA, Scripps Institution of Oceanography

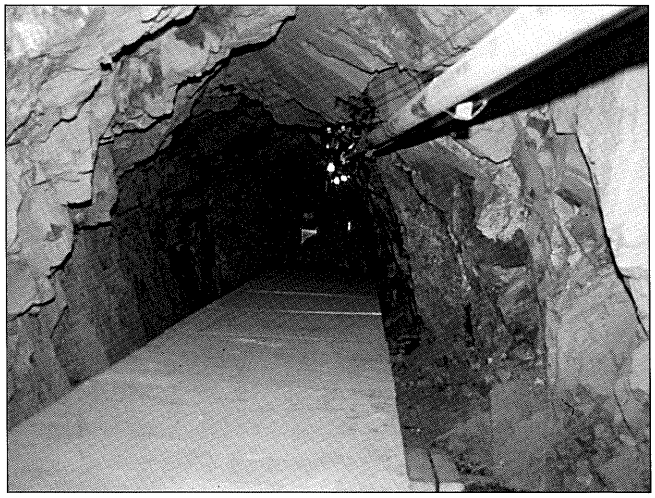
During the International Geophysical Year of 1957, California Institute of Technology (Caltech), extending their studies on earth tides and crustal deformation to central Peru, sponsored the installation of two Benioff horizontal extension meters (25 m long quartz rods) in the neighborhood of Lima in collaboration with the Geophysical Institute of Peru (IGP). After careful survey, a location close to the small town of Naña, 25 km east of Lima, was selected. To house the instruments, a 'Y' shaped tunnel was excavated into solid gabbroic rock formations at the foot of a mountain now known as the Extensometer Mountain. The principal tunnel section is 40 meters long and the inner branches, oriented N40°W and N60°E, are each 30 meters long. Piers for seismographic equipment were also included. The relief of the area represents the west rising edge of the western Andean cordillera.

In 1962, the U.S. Coast and Geodetic Survey and the U.S. Geological Survey's Albuquerque Seismological Laboratory enhanced the NNA facility by installation of a World Wide Standard Seismographic Network (WWSSN) system. This consisted of short-period Benioff (T=1 sec) and long-period Press-Ewing (T=30 sec) seismometers. Seismic signals were recorded on photographic paper until July 1987, when the system was outfitted with a heated stylus recording system. With the upgrade, only four of the six channels (1 SP and 3 LP) were recorded.



Edmundo Norabuena of IGP checks out the new IRIS-3 data acquisition system.

In the 1970's, seismologists at Institute of Geophysics and Planetary Physics, University of California, San Diego, began Project IDA, a global seismographic network designed to enhance studies of the Earth's deep interior by digitally recording very-long period ground accelerations using modified LaCoste-Romberg gravimeters.



Inside the NNA tunnel. Extension meter lies under the concrete flooring.

NNA became one of the first IDA stations in 1975. Later, in partnership with the new IRIS Consortium of universities, UCSD continued improving the type and quality of data gathered at IDA stations and in 1987 they upgraded the NNA station to become the first digital broadband system covering western South America. Data from three Streckeisen STS-1 seismometers were recorded on 40 megabyte cartridge tapes using a dual-gain data acquisition system with a continuous sample rate of 5 Hz.

In December 1993, IDA staff replaced the original broadband data acquisition system with the current 'IRIS-3' version. In addition to the Streckeisen sensors, the new system includes three short-period Teledyne Geotech GS-13 seismometers which are currently recorded in triggered mode at 100 samples per second. The STS-1 sensors are digitized on a single gain high-resolution converter and data streams of 20, 1, and .1 samples per second are continuously recorded on digital-audio (DAT) tape. Timing is provided by a GOES satellite clock. The IRIS/IDA station at NNA is operated by the Geophysical Institute of Peru, which joined IRIS as a foreign affiliate in 1993.

In addition to the seismic instrumentation described here, a Sacks-Evertson borehole strainmeter buried 100 meters deep is located at the entrance of the NNA tunnel. Changes of

volume detected by the sensor are used to measure crustal deformation which is chart recorded at 0.5 inch/hour. This instrument is part of a joint project between the Department of Terrestrial Magnetism of the Carnegie Institution of Washington and IGP.

As an official government agency, the Geophysical Institute of Peru is responsible for carrying out geophysical activities within the country and for maintaining a real time seismic network capable of monitoring seismic activity and evaluating seismic hazards within the area. However, the economic situation and vandalism over the past few years have seriously affected the network's potential, particularly in remote areas. Today only a few stations send data in real time to the central site. As a geophysical data center, IGP collects gravimetric, magnetic, and acceleration data in addition to seismic data. Two regional seismological observatories complement the central site: Huancayo (300 km east of Lima) and Arequipa (900 km southeast of Lima).

The Geophysical Institute plans with UCSD to install a digital telemetry link between the NNA station and the Institute's Seismic Detection Center in Lima. This three-point link will bring continuous data streams from the IRIS/IDA data acquisition system to IGP's computer network (about 16 km line of sight). The IRIS/IDA Data Collection Center at UCSD and the IRIS GOPHER system would then access NNA data either through Internet or by dial-up access. We hope that this project will become a reality in the very near future. •

Visiting Scientist Support at IRIS Data Management Center

The IRIS Data Management System encourages scientists to avail themselves of arrangements that have been made for visitors to the Data Management Center in Seattle to use the center's computer and archive facilities and interact with DMC staff. We are especially interested in hosting scientists who have a well defined need to visit the DMC to work in close proximity to the archive for GSN and PASSCAL data and to develop innovative uses of the mass store and archive. We are also interested in working directly with researchers in order to improve the procedures IRIS provides for data access. In general, we would like to have visits of between 2 weeks and 3 months duration.

The IRIS DMC possesses an 8.6 terabyte mass storage system that contains primarily data from the IRIS Global Seismic Network and the Federation of Digital Seismic Network such as GEOSCOPE, MEDNET, CNSN, CDSN, pre-POSEIDON and Graefenberg data. We also have data from all PASSCAL experiments listed in the Electronic Bulletin Board, Information Products from the JSP Center and a variety of other data sets such as the data from the IDA gravimeter network and data from Apollo Moon landings.

In addition to the large mass storage system we will soon have another system (named YODA, Your Own Data Area) primarily reserved for use by visiting scientists. YODA is a Sparcstation 10 configured with all appropriate software to perform seismic analysis in addition to an essentially unlimited amount of storage that appears as a UNIX file system. This unlimited storage space is provided by two METRUM ST2150 high performance helical scan tape devices with I/O rates of 2 megabytes per second. Controlled by AMASS software the data on the ST2150 tapes appear to the user as a UNIX file system. Since 65,000 tapes each containing 20 gigabytes (1.3 million gigabytes = 1,300,000,000,000,000 bytes) can be managed by AMASS, this capacity is essentially unlimited. PASSCAL experimenters may find this data area very attractive to perform large data sorts where massive storage is unavailable on their own systems.

Limited financial support can be provided to help defray travel and living expenses. Preference will be given to members of IRIS institutions. It is intended to keep the level of support modest in order to have a greater number of scientists participate. It is expected that the DMS support is only partial support and will be augmented by other sources. Support of up to $3000 may be provided for successful applicants.

Interested scientists should send a short letter to Dr. Tim Ahern at the IRIS DMC in Seattle. The letter should indicate why close proximity to the IRIS archive will assist your scientific studies, the level of support requested, and the potential benefit to IRIS of having your study conducted close to the staff of the IRIS Data Management Center. At the DMC, we would like to make this an opportunity to improve the DMC facility by having close interaction between the scientific community and DMC staff. •

Tim Ahern, DMS Program Manager

This Issue's Bannergram: The bannergram on the cover shows the long period channel (1 sps) from the GEOFON station MORC in Northern Moravia (Czech Republic) for the disastrous Ms=6.7 Northridge earthquake near Los Angeles on January 17, 1994. The distance to the epicenter is 88 degrees. •

Winfried Hanka, GeoForschungsZentrum, Potsdam, Germany

IRIS GOPHER is Dead, Long Live IRIS SPYDER

Steve Malone, University of Washington & IRIS Data Management Center

The IRIS GOPHER system for rapidly providing seismic waveforms to seismologists following large earthquakes has been a great success. For the original description of this system see the November 1989 IRIS Newsletter. The current monthly average of about 1,000 accesses and 500 MBytes of downloaded data for over 100 different individual users attests to its popularity. Unfortunately, this system's name, GOPHER (which was chosen in 1988) has been usurped more recently by the popular Internet GOPHER, a distributed document search and retrieval protocol used on the information super highway (IP port 70). With the potential for increasing confusion to seismologists between these two types of GOPHERs, a name change for one of them is demanded. Being a very small and specialized subset of Internet usage, it looks like the IRIS GOPHER will need to be killed and a SPYDER (System to Provide You Data from Earthquakes Rapidly) resurrected in its place.

As of April 7, 1994 (time of the IRIS workshop) access to waveform data from recent earthquakes will be through the IRIS bulletin board (rlogin dmc.iris.washington.edu -l bulletin with password: board) using the SPYDER option. A direct login to the SPYDER system (as available before with GOPHER) will be discontinued because of repeated security violations through this less secure access technique. All of the current display and data retrieval capabilities will continue under SPYDER; however, there will be some new features and access techniques available. Also, all SPYDER data will be available through the anonymous FTP mechanism on dmc.iris.washington.edu in directory *pub/spyder.*

Data available to IRIS DMC users continue to expand and access techniques to evolve. The planned SPYDER system will have considerably more data available with easier access than the original 1989 GOPHER system. The following is a very quick summary of the original GOPHER design goals, things that have changed, and some ideas for the near future.

Original Design Goals:

- Provide waveform data from some IRIS GSN stations for large or interesting earthquakes to the seismology community soon after the event occurs.
- Provide a relatively simple, easy to use user interface which allows limited data review and down loading to a user's own computer.
- Provide quality assurance information rapidly so that station malfunctions can be rapidly identified.
- Provide a real-world test bed to experiment with and develop new data acquisition techniques.

Developments since the original GOPHER:

- Distributed GOPHER systems collect data using many different computers around the world (DMC, University of Washington and CIT in USA, ORFEUS in Netherlands, ERI in Japan, University of Hawaii in Hawaii, IGNS in New Zealand, ANU in Australia)
- Symmetrical Gopher/Badger operation so that systems can be fairly independent of each other (Badger systems to initiate data acquisition for local events are now running at University of Washington, CIT, ERI, ORFEUS, and GEOFON).
- Flexible data distribution (selected data are automatically distributed to other data centers such as the IRIS Waveform Quality Center at Harvard, Albuquerque Seismic Lab, Pacific Tsunami Warning Center in Hawaii, ORFEUS in The Netherlands, ERI in Japan, and the NEIC)
- Integration of data from other networks (GEOSCOPE data are now routinely acquired)
- Provide limited response information (latest pole-zero response information is now included in data recovered in AH format).
- X-Windows user interface includes display of seismograms and map of current quarter's epicenters and separate maps of epicenter and seismograph stations of selected earthquake.
- Rapid automatic notification by NEIC of earthquakes so that broadband data from worldwide stations can be recovered and distributed to NEIC for their use in updating hypocenter determinations.

Future Plans:

- Integrate additional data sources into the SPYDER archive including, in the near future, US National Network Data (USNSN) and Global Telemetered Seismic Network data (GTSN).
- Use SEED format rather than SAC for SPYDER data so that it contains more complete information and is more like other IRIS data.
- Integrate SPYDER data with IRIS FARM data so that the interface and access techniques are the same for recent earthquakes from dial-up sources as well as quality checked data from the master archives.
- In addition to the current user interface provide one which is more general and based on one (or more) of the developing Internet distributed information systems (World-Wide-Web, Internet GOPHER, WAIS...) •

IDA Update

Holly Given, Executive Director, Project IDA

This column is meant to be an informal way to update the IRIS community on progress toward the Global Seismographic Network by the IDA group at Scripps Institution of Oceanography. More in-depth information about data from stations discussed here is available through the tools of the IRIS Data Management System.

IRIS/IDA station FFC (Flin Flon, Canada) became operational on August 28, 1993. The Geological Survey of Canada is providing the vault and recording building for this station in western Manitoba, located 6 miles southwest of the small mining town of Flin Flon. The IRIS instruments are in an underground vault accessed via a vertical 15 foot shaft. Long-period ground noise is very low for a vault deployment; Earth tides are apparent on all three components.

IRIS/IDA station TAU (Hobart, Tasmania) became operational on January 17, 1994, using the vault from the DWWSSN station which has since been decommissioned. This station is a surface vault in a quiet residential neighborhood in the hills above University of Tasmania, somewhat reminiscent of the setting of PAS (Pasadena, California). TAU is the first IRIS/IDA station where the data acquisition system is connected directly to Internet, something we hope will become increasingly common in the near future. Among the first significant earthquakes recorded were several large Indonesian events and some of the larger aftershocks of the Northridge earthquake (unfortunately a calibration procedure was running at the time of the mainshock). The installation team dubbed TAU 'the vault with a view' as it affords a lovely vantage point of the Derwent River and the Hobart suburbs.

In November, systems at IRIS/IDA stations ESK (Eskdalemuir, Scotland) and NNA (Naña, Peru) were upgraded, replacing all but the seismometers and clocks. These upgrades eliminated the last of the original IDA broad band acquisition systems from the mid 1980's that sampled STS-1 sensors continuously at 5 Hz, triggered at 20 Hz. Users should note that instrument responses and channelization at ESK and NNA changed in November; please be sure to get current information from the IRIS DMS.

IDA engineer, Anthony Wei, emerges from the vault at IRIS station FFC (Flin Flon, Canada).

FFC, ESK, NNA and TAU all deploy the current IRIS/IDA ('IRIS-3') acquisition system which records STS-1 sensors on single-gain, high-resolution channels at 20, 1, and .1 samples per second continuously. Additionally at FFC and NNA, high-frequency GS-13 sensors are recorded at 100 samples per second in a triggered mode. FFC, ESK, and TAU also participate in the IRIS GOPHER system via the IDA NRTS (Near Real Time System); a dedicated telemetry link between NNA and the Geophysical Institute of Peru is planned to add real time capability to NNA.

Data acquisition systems at ARU (Arti, Russia), KIV (Kislovodsk, Russia) and AAK (Ala-Archa, Kyrgyzstan) were upgraded in December and January. At KIV, sensors were moved from the basement of the recording building to a new vault nearby, where it is hoped that long period horizontal ground noise will be substantially lower. The ARU and KIV upgrades replaced systems originally deployed in 1988 that were of a special design to meet export controls in place at that time. These systems had some disadvantages due to the ""low tech" requirement; mainly, recording was on 1600 bpi 9-track

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the IRIS CONSORTIUM

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The IRIS Newsletter welcomes contributed articles. Articles should be less than 1000 words and four figures. Please send articles or requests for details on submission of articles to the address listed above. Electronic submission is encouraged.

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Production Editor: Denise Dillman Crump (denise@iris.edu)

CALENDAR

APRIL

5-7	SSA Meeting, Pasadena, California
7-10	Sixth Annual IRIS Workshop, Glendale, California
15	UNAVCO/IRIS

MAY

8	Tenth Anniversary of IRIS' Incorporation
23-27	Spring AGU, Baltimore, Maryland

JUNE

19-24	International Conference on Mathmatical Geophysics, France

New Members

IRIS welcomes Honn Kao, as representative for Institute of Earth Sciences, Academia Sinica, Taiwan as a new foreign affiliate and Francis Monastero as representative for Geothermal Program Office, Naval Air Weapons Station, China Lake, California as a new affiliate. •

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tape which held only about 24 hours of data, resulting in some data loss if the operator did not change the tape punctually or if large amplitude events filled the tape early due to less-than-usual efficiency in data compression. A dedicated communications link exists from Bishkek, Kyrgyzstan to Obninsk; we hope to complete the last leg from Bishkek to Ala-Archa this year to bring AAK into the NRTS. This will allow AAK to join stations ARU, OBN, and KIV as IRIS stations in the former Soviet Union available through Gopher.

IRIS/IDA station NVS (Novosibirsk, Russia) had been installed with the condition that Russian authorities would review initial data and decide whether or not to grant permission for routine data release. NVS has been operating since July 1992, but permission has never been granted although many decision dates have come and gone. After waiting out many of these deadlines without a positive outcome, we regrettably had to make the decision to remove the equipment from NVS for use elsewhere.

In August 1993, a borehole was completed at the future Monasavu Dam site on Viti Levu, Fiji by the Institute of Geological and Nuclear Sciences (IGNS) of New Zealand. In November, a borehole at the future site near Borgarnes in western Iceland was finished under the supervision of the Science Institute of University of Iceland. In September, IDA staff visited the Azore Islands and, with the Instituto Nacional de Meteorologia y Geofísica, identified a site near the center of Saõ Miguel Island on land controlled by the Forest Service where a borehole is planned. In February, staff from IDA and the New Zealand IGNS traveled to Ascension Island and the Falkland Islands to evaluate drilling tasks this summer at future IRIS sites on those islands.

A KS54000-I broadband borehole seismometer was installed at Piñon Flat Observatory (PFO) in December 1993; about 5 meters away, another KS54000-I is being tested in a wet hole in a special pressure casing to simulate conditions on the ocean floor in an NSF-funded project for the Ocean Seismic Network by John Orcutt and Frank Vernon of Scripps and Ralph Stephen of Woods Hole.

We are happy to announce the arrival of Dr. Peter Davis at Project IDA in November 1993. Since receiving his degree at Princeton in 1986, Pete has held positions at Carnegie Institution of Washington, the Graefenberg array in Germany, and Teledyne Geotech in Alexandria, Virginia. He joins us as Director of the IDA Data Collection Center. •

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