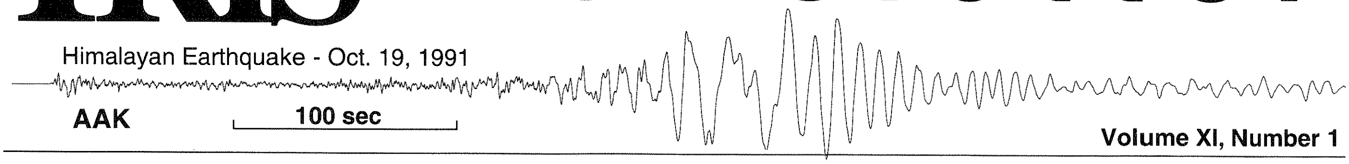
IRIS Newsletter



Volume XI, Number 1

From the President

This issue of the Newsletter will appear when many of you are attending the Fourth IRIS Workshop in Santa Fe. The Workshops have become an important annual opportunity to review the accomplishments of IRIS and to allow members to participate in developing new programs.

Scientific sessions at the Workshop will review the current and potential use of IRIS data for investigations of the Earth's crust and deep interior and for earthquake studies (both GSN data for rapid determination of source parameters and use of PASSCAL instruments for recording aftershocks). A joint session with SSA, on the seismicity and structure of Eurasia, will highlight data from the Joint Seismic Program.

A Special Interest Group (SIG) on Education will explore how IRIS can be involved in developing curricula and equipment for use in high schools, including the design of an inexpensive seismograph for school use.

Other SIGS will focus on: the use of PASSCAL instruments in aftershock studies and in "transportable arrays"; plans for the siting of new stations for the GSN; software development; and the rescue of valuable historical seismic data. Tutorials will show how to access data from the IRIS Data Management Center.

In July, IRIS begins its second year of funding under the new Cooperative Agreement with NSF. The past year has seen healthy growth in the IRIS programs. We look forward to your input on how to keep IRIS active and responsive to the needs of the research community. •

David Simpson, President

Berkeley Digital Seismic Network: A Broadband Network for Northern and Central California

Barbara Romanowicz, Lind Gee and Robert Uhrhammer
Seismographic Station, University of California, Berkeley

The Seismographic Station at UC Berkeley has a long tradition in operating seismographic stations in Northern and Central California, dating back to 1887. The first broadband instruments were installed in 1963. By May 1987, six broadband stations were operational (BDSN: Berkeley Digital Seismic Network), three of which were equipped with STS-1 seismometers. A 16-bit digital telemetry system was also designed at that time, to bring back broadband data from three of the stations. Figure 1 shows the vertical component broadband records for the Whittier Narrows earth-

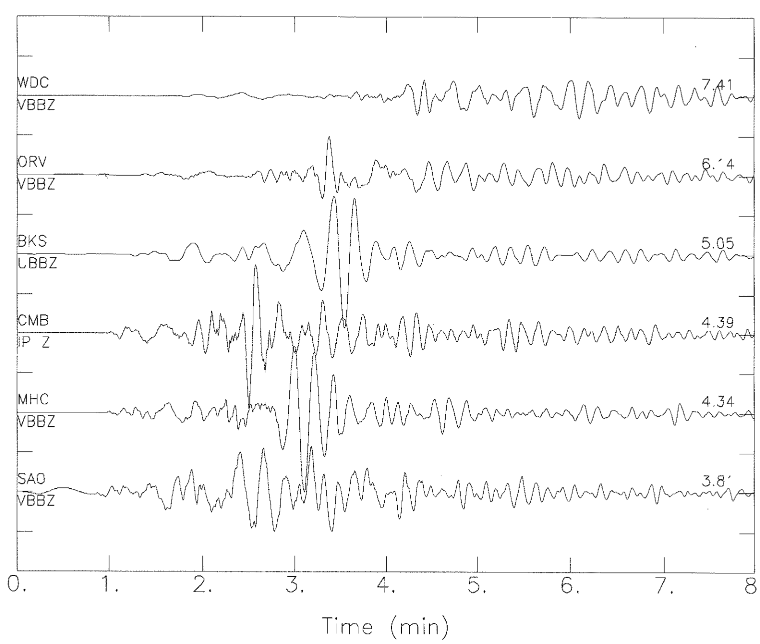


Figure 1. Vertical component broadband records of the Whittier Narrows earthquake of October 1, 1987 (Ms= 6.4) at six broadband stations of the Berkeley Network. The records have been deconvolved to ground displacement and arranged as a function of epicentral distance, indicated in degrees on the right of each record.

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What's Inside

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quake of October 1987, at these six stations.

In January 1991, a major upgrade of the Seismographic Station was initiated, with significant funding from the University of California. A key component of this upgrade is the expansion of the existing broadband digital network to about 20 stations, spanning the entire range of frequencies and ground motions of interest to local, regional as well as global studies. The basic instrumentation will consist of Streckeisen STS-1 or STS-2 three component seismometers, complemented with strong motion accelerometers as well as slow deformation sensors.

The Broadband Network: Status and Plans

Figure 2 shows the distribution of existing and planned broadband stations in Northern and Central California. The first step has been to upgrade the two existing STS-1 sets (MHC and SAO), which had initially been installed in the original "broadband" version (Wielandt and Streckeisen, 1982), to the "very broadband" (VBB) version (Wielandt and Steim,

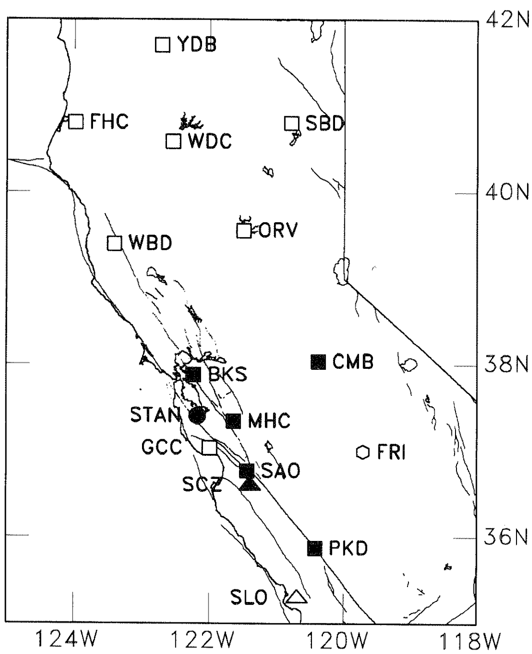

Figure 2. Existing (filled symbols) and planned (open symbols) broadband stations in Northern and Central California contributed by different institutions: U.C. Berkeley (squares), U.C. Santa Cruz (triangles), Stanford U. (circle), joint UCB/UCSC site (hexagon).

1986). An STS-1 seismometer, an FBA-23 accelerometer and a Quanterra station processor have been installed at BKS, making it our prototype VBB/24 bit system. Data from BKS are transmitted to the Earth Sciences Building on campus via dedicated phone line. The following channels are recorded: continuous data at sampling rates of 20, 1, and 0.1 Hz; triggered data at a sampling rate of 80 Hz ("VSP" channel); as well as low gain triggered data from the FBA-23 accelerometers, also at 80 Hz sampling rate. Since last summer, the Adebahr System Technik (AST) software originally designed for the German Regional Network, has been installed at the Seismographic Station, to manage data collection from multiple sites onto a SUN Sparc-2 workstation. Currently, we are acquiring data in this fashion from BKS as well as STAN, the STS-2/Quanterra system installed and operated by Stanford University (same channels as for BKS). For STAN, the data are transmitted in real time via the USGS/Menlo Park microwave network between Menlo Park and Vollmer Peak, in the Berkeley Hills. This data transmission arrangement is a cooperative effort between UC Berkeley and USGS/Menlo Park. Since October 1991, we are also receiving data via microwave telemetry from a temporary STS-2 installation at Parkfield (PKD), using the 16 bit telemetry system, while waiting for a more permanent site and a Quanterra recording system.

In addition to searching for a permanent site at Parkfield, which will receive an STS-1 seismometer, we are currently preparing the following installations:

- upgrade of MHC and SAO to the "standard" system (BKS) by installing Quanterra recording systems and low gain accelerometers.
- installation of an STS-2/Quanterra/FBA-23 system at Whiskeytown (WDC), in the Northern Sierras. This is one of Berkeley's quietest sites (a natural cave). The new equipment requires the construction of a new cabin to house the recording equipment.
- installation of an STS-1/Quanterra system at Columbia (CMB). This station has been contributing digital data to the Global Digital Seismic Network since 1987, acquired from a set of Guralp CMG-3 sensors through a DWWSSN recording system, on loan from USGS/ASL. The upgrade is partly supported through a contribution from the IRIS GSN. The data will be transmitted continuously to Berkeley via phone and from there transmitted to the Albuquerque Data Collection Center to be merged with the IRIS data stream.

By the end of April 1992, we therefore plan to have seven operational stations (including STAN, for which we will provide some technical and upgrade support) transmitting data in real time to U.C. Berkeley. The same channels as described for BKS will be telemetered using either phone lines or the USGS microwave network.

Stations WDC, CMB and SAO will also contribute to the US National Seismic Network (USNSN). To this end, satellite antennas have already been installed at those three sites and also on the roof of the Earth Sciences Building at Berkeley. Data will be transmitted to Golden, Colorado, via satellite and rebroadcast to Berkeley, along with data from a selection of other USNSN sites. In addition to antennas and software, the USGS is contributing clocks for those three stations.

There will thus be redundancy in data collection at these three sites, in the event of failure of the "ground" telemetry

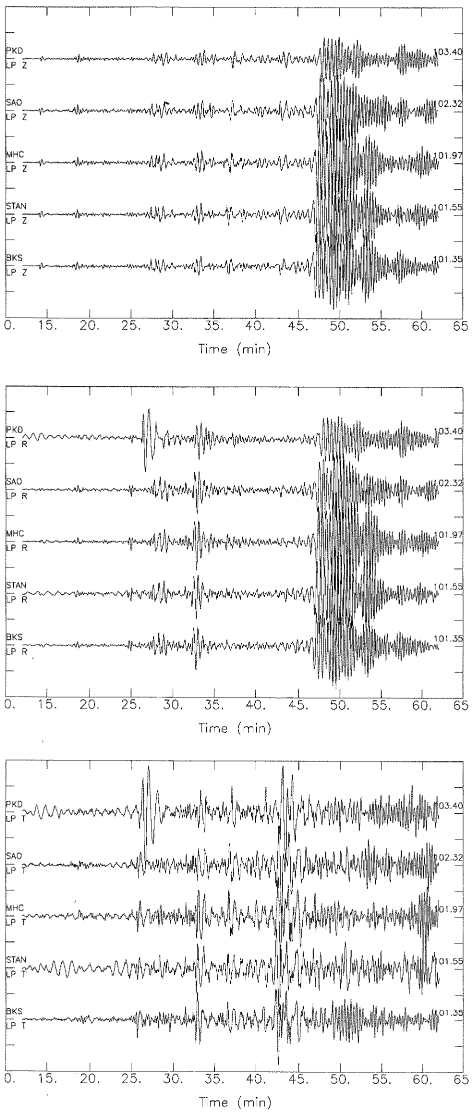

Figure 3. Philippine earthquake of November 13, 1991 observed at 5 broadband stations in Central California (distance ~102°). The records are deconvolved to ground displacement. From top to bottom: vertical, radial and transverse components. The low frequency dispersed pulse around 11:12:27 on the horizontal components at PKD is a noise glitch.

system. In any case, all remote sites will have Quanterra processors with enough memory to allow retrieval of data over two-four days if the telemetry connection is temporarily lost.

Other Plans for 1992

In Spring 1991, we ordered four STS-1 and two STS-2 instruments, which we hope to install in the second half of 1992. We plan to upgrade station ORV and to install two new sites in the Northern Coast Ranges and two new sites in the northernmost part of California, in cooperation with Humbolt State University (Figure 2). These four new sites may include the construction of several new vaults. One STS-2 will be kept as a portable unit (with a PASSCAL recording system) for site testing and temporary deployment.

We are in the process of analyzing test data from four sites in the Fresno area, for a joint installation with UC Santa Cruz. We also plan to continuously telemeter data from UCSC/GEOSCOPE station SCZ and the planned UCSC station near San Luis Obispo.

Real-time Data Processing

Until a year ago, the routine analysis procedures at Berkeley were primarily based on reading arrival times from the 19 station short-period Berkeley network, and amplitudes from the four Wood Anderson instruments located at BKS, MHC, and two Northern California sites. The times were read from develocorder film and helicorder records after data collection by analog telemetry and entered by hand into a PC-based database.

Currently, the data from the short-period network are being acquired and digitized through an IBM-50Z microcomputer and forwarded to a SPARC-2 SUN workstation for analysis using software developed by R. Crosson and collaborators at the University of Washington. The Berkeley event detectors and earthquake locators have been interfaced with this software and the processing of a day's events typically now takes one half hour of operator time, about 8-10 times less than previously.

This is, however, only an intermediate step towards our goal, which is to fully integrate the broadband data into the routine analysis and ultimately phase out the old short-period network. We anticipate that this will be possible when 10-15 broadband stations are installed and operational, hopefully by the end of 1993. We are currently developing procedures for real-time event extraction from the broadband datastream, as well as new data analysis tools, including waveform modelling and moment tensor inversion, in order to provide not only location and magnitude information, but also source mechanism and moment estimates in quasi-real time.

We are also currently involved in a careful comparison and calibration of real Wood-Anderson recordings with synthetized ones, obtained from the STS instruments at BKS and MHC, with the intent of ultimately shutting down three of the four Wood-Anderson instruments currently operated by Berkeley. We are also investigating ways of digitally recording the Berkeley Wood-Anderson.

The Hayward Fault Project

A network of 24 borehole stations with very wide dynamic range is being planned to instrument the Hayward Fault. This is a joint UCB/USGS project, funded by USGS (T. McEvilly and W. Ellsworth, P.I.'s). Menlo Park will manage the Southern part of the Hayward Fault Project, U.C. Berkeley the Northern part (12 stations each). In 1992, Berkeley will install six stations, equipped with three component wide band accelerometers (0.05-600Hz) as well as three component 4.5 Hz velocity geophones. The six channels will be sampled at 1000 Hz, using Quanterra 24-bit processors, and the data will be collected in real time at UC Berkeley using the same software as for the regional broadband network. A DAT recorder will be installed at each site for back-up.

UCB/USGS Data Center

The data from the broadband digital stations are currently archived on Exabyte tapes (since January 1991). Meanwhile, we are developing a Data Center, jointly funded by UCB and USGS/Menlo Park, for the archival and distribution of data from the BDSN as well as wave-

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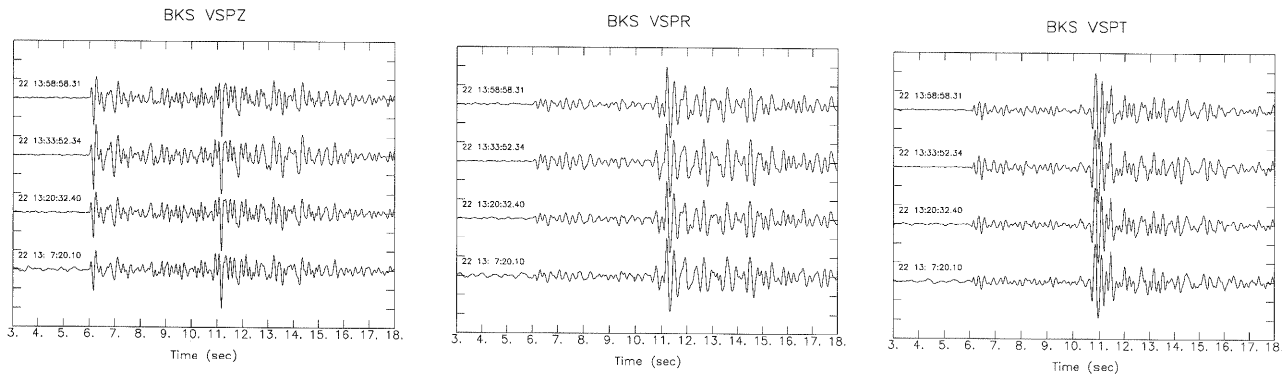

Figure 4. "Pacifica" sequence of January 22, 1992 observed at BKS on the VSP channel (distance ~ 33 km). From left to right: vertical, radial and transverse components. From bottom to top, in chronological sequence, the magnitudes are respectively: m_L = 1.2, 1.7, 2.0, 1.9. The raw velocity records have been normalized to maximum amplitude.

form data from the CalNet-CUSP Northern and Central California network.

The data will reside on a 330 Gbytes Worm SONY "juke-box", accessible through Internet. The software development for data archival and retrieval is being closely coordinated with the SCEC Data Center at Caltech, which is installing the same hardware/software system. The basic software for access to the juke-box is the "AMASS" software (also chosen by the IRIS DMC) and we are currently experimenting with the IRIS-DMC database software for data retrieval. Arrangement will be made for long-term archiving of continuous BDSN data at the IRIS DMC.

Northern and Central California Broadband and CUSP Data

After quality control, the broadband data will be transferred to the juke-box within a period of about a week. In the meantime, data from "interesting" earthquakes will be accessible on disk (before quality control), as will be a selection of event data repeatedly requested from the mass-store over several weeks to several months time. Two or three stations, starting with BKS, will be available through the IRIS GOPHER/BADGER system, allowing rapid access to data from large earthquakes.

We plan to start loading the current data first, then add the complete collection of BDSN data (1986-1990). We are discussing the possibility of exchanging part of our data collections with SCEC for redundancy purposes. The CUSP collection will be transferred from tapes to DAT's at Menlo Park and then loaded on the mass-store at Berkeley.

Other Data

The mass-store will also contain data from the Hayward Fault network, and the planned Menlo Park/Stanford GPS data collection. We also plan to load a selection of GEOSCOPE data, and to develop a strong motion data collection.

Other Future Plans

We are planning to complete the instrumentation of our broadband stations by adding GPS receivers for continuous monitoring of deformation on the regional scale. To begin with, in 1992, we will install two GPS receivers across the Hayward Fault, in the vicinity of Berkeley, to complement the four GPS stations installed in the Bay Area by USGS and Stanford. We are also contemplating the installation of borehole strainmeters and other geophysical instrumentation of interest for the study of deformation and earthquake precursory phenomena.

Beyond the 15 permanent Northern California stations, we are investigating the possibility of installing several offshore ocean bottom broadband stations to help fill the gap on the western side of the plate boundary, in cooperation with other agencies. Also five to 10 additional PASSCAL-type stations will be installed at semi-permanent sites, which could be moved every two-three years, according to specific research interests.

We hope to develop close cooperation with IRIS and other institutions involved in the deployment of broadband stations in neighboring states, such as the University of Nevada, Reno, Oregon State University, and also, in California, LLNL, to rationalize efficient data exchange.

On-going Research Projects Using Broadband Data

The broadband data which we are collecting are providing new opportunities for the study of problems of both local and global interest, as shown in numerous presentations at the Workshop on "Frontiers in Broadband Seismology" held at U.C. Berkeley on January 9-10, 1992. We illustrate this point by presenting several examples of broadband records of recent events, in different epicentral distance ranges. Figure 3 shows an example of a teleseism, the Philippine earthquake of 11/13/91 (Ms=6.4), observed at five of our stations, all located at an epicentral distance of around 103°. Many interesting body wave phases are present, and we note the similarity in waveforms across the network in this example. The installation of 10 or more additional stations will allow detailed studies of the deep mantle and core using this type of data.

Figure 4 shows an example of a remarkable sequence of four earthquakes, which occurred in the same location on 01/22/1992, near Pacifica, in the San Fransisco Bay Area. These events have been recorded on the VSP channel at BKS (distance =33km). We note the remarkable similarity of waveforms for these four events, which span a magnitude range m_L= 1.2 to 2.0, and thus contribute to useful observations for the study of scaling laws of small earthquakes.

We are currently concentrating our efforts, at Berkeley, in developing various theoretical and observational approaches for the study of California structure and earthquake source parameters. This includes waveform modelling at regional distances and moment tensor inversion, as well as more classical studies of surface wave dispersion and receiver functions. We are also investigating the possibility of using the regional network as an array for the study of deep structure of the mantle and core.

For this and other research purposes, the computer facilities at the Seismographic Station are being significantly upgraded, with joint funding from the university and NSF. These facilities will be shared with the Department of Geology and Geophysics.•

PASSCAL Earthquake Recording for Freshman Field Program

Robert Phinney, Princeton University

Figure 1. Princeton undergrads Naomi Darling, left, and Andrea Menotti, right, deploying PASSCAL equipment at Long Valley, California.

The popular Geology 201c option at Princeton University takes 20 new freshmen enrolled in the basic Physical Geology course to Long Valley each fall break. Students with no special background, except their initial freshman enthusiasm and their Ivy League SAT's, are exposed to recently active volcanism, to fault-cut moraines, to the Bishop tuff, to lower Cambrian Archaeocyathids. The setting brings in an opportunity to discuss the removal of Sierra water from the Mono Basin and the difficulty of using the word "volcano" around residents of the Long Valley area. The trips originate in Las Vegas, permitting visits to Death Valley and Owens Valley. The instructors, Bob Phinney, Ken Deffeyes, and Jason Morgan, get their enthusiasm by being non-specialists in the area.

While the course has firmly established the gee-whiz motivation for field work, we now want to give some experience of the "hard science" side, to demonstrate the unique mixture of field observations, theory, and technology which are so enjoyable to practicing earth scientists. For the 1991 trip, a small crossed PASSCAL array for microearthquake recording was deployed near the village of Mammoth Lakes, and data acquired each day were played back on the Sun field computer in our headquarters condo. To avoid introducing math/science anxiety, we made the exercise optional; this promoted some curiosity and led to about half the group coming out on a volunteer basis to help in deployment and data downloading.

The experiment made use of three six-channel Reftek dataloggers co-located at the origin of the microarray (Figure 2). One instrument recorded the outputs from two co-located L-22 three-component seismometers, and the others each recorded six vertical geophones deployed on the arms of a + shaped array at 100 m spacing. The station was located 250 m east of the Forest Service helipad near Mammoth lakes, and very close to the events which occur in the South Moat with great regularity.

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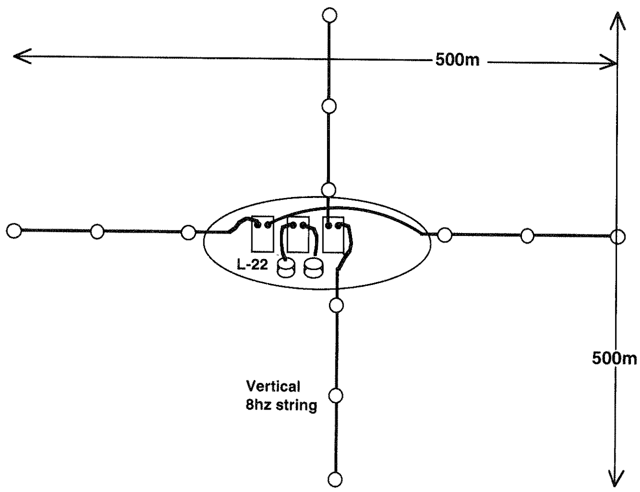

Figure 2. PASSCAL array geometery during Princeton field camp.

Data recording on all three instruments was event-triggered from the NS array, and sampled at 200 sps. A continuous 20 sps recording stream was run off the L-22's. About three full days of nominal data acquisition was achieved, with approximately 75 events triggered. About 50 of these occur on the USGS catalog for the Long Valley network.

The experiment was to serve as a prototype for a microarray which could use beam-steering to approximately locate nearby events. The determination of S-P time from the horizontal components is necessary to provide an estimate of the hypocenter offset along the arrival direction. In the figure are displayed the signals from two "twin" events located to the northeast of the station. Moveout along the legs of is not strictly linear, indicating severe near-surface static problems, and the local geology has almost entirely degraded any coherent shear arrival. These effects are perhaps worse in the Long Valley caldera than elsewhere, but the time constraints of the experiment required a reliable source of nearby daily microearthquakes.

Conclusions: Two of the students have remained with the program, and are now helping to produce a catalog and to conduct the basic analysis of the array results. The effort cost $2000, mostly for shipping expenses. We plan to repeat the experiment in future years. The second time, the station will be located on Sierra basement, just south of the caldera boundary, where local microseismicity is common, and where a comparison of S-wave character with the South Moat site can be made. It is planned to add a graduate student instructor to the effort, to eliminate competition for the time of the instructor between the geology program and the seismic experiment. The experiment can be considered cumulative, in the sense that data and experience from year to year can cumulate into a data set for student research. By the same token, exchange of waveform and catalog information with the existing networks operated by the USGS and the University of Nevada can further enhance the utility of the experiment for student research.

The PASSCAL instruments worked well, and the sound of the disk powering up for the after-dusk data retrieval in freezing weather had a certain miraculous quality. However, the hand-held terminal proved to be unsuitable for this kind of experimental-instructional work, where the configuration is complex (each datalogger had a different configuration), and where experimental changes of setup were desired. It proved nearly impossible to conduct a site visit without making one or two errors. It would be much more desirable to have a laptop computer with software to ensure proper up- and down-load sequences and to check parameters for consistency. For example, it is possible to select three channels for recording but to have triggers enabled on six channels; the open channels produced noise spikes which produced false triggers.

Based on this experience, we are trying to piece together funding to acquire five three-channel Reftek dataloggers for use in teaching and in experimental prototyping. Any university which has plans to work with portable instruments should have a few instruments as a base for hands-on experience. This is especially the case if 20-40 groups want to borrow a few instruments for a week or two each year, since the demand of such loans could be a serious extra burden on the PASSCAL instrument centers. •

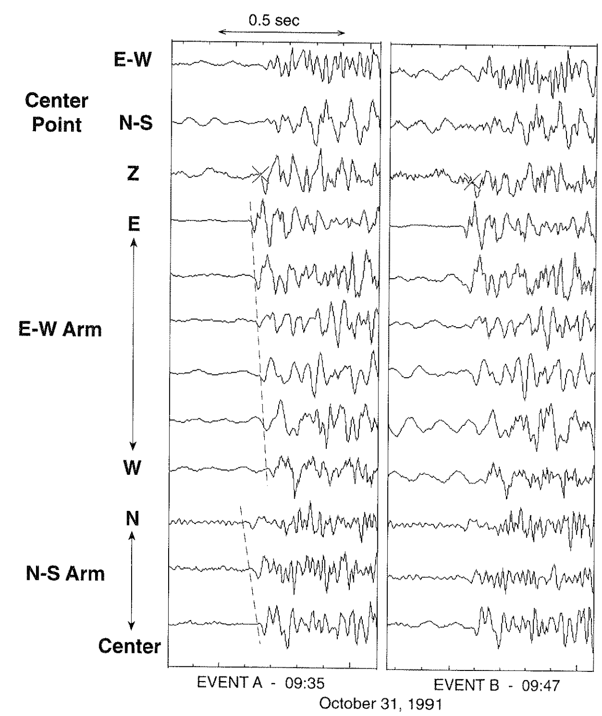

Figure 3. Two local microearthquakes approximately 5 km from the array at Long Valley.

Kyrghizstan Seismic Telemetry Network

Frank Vernon, IGPP, University of California, San Diego

Apprehension was high for the US and Soviet scientists in Bishkek, Kirghizstan, on the morning of August 12, 1991. The equipment for a ten station, broadband digital telemetry array along with a local processing center, shipped from San Diego on July 24, was finally arriving. During the first week of their odyssey, eighty-eight crates of equipment had safely made it to Moscow without a loss. From there, the boxes were placed on a truck to Bishkek and headed southeast for the last 3500 kilometers of their journey. A one week delay was caused by a truck breakdown. When the truck arrived, we despaired at the condition of the shipping crates, which were covered with dirt and soot. During the next few days everything was organized and tested. To our surprise there was relatively little equipment damage and nothing which could not be repaired. Over the next six weeks, the US and Soviet teams, although distracted during the attempted coup in Moscow, cooperated in the deployment of ten remote seismic stations, a central receiving site, and a data collection and processing site (Figure 1). The US group consisted of personnel from the University of California at San Diego (UCSD) and Indiana University (IU) and the Soviets were represented by the Kirghiz Institute of Seismology (KIS), the Institute of Physics of the Earth (IPE), and the Institute of High Temperature Physics (IFTAN).

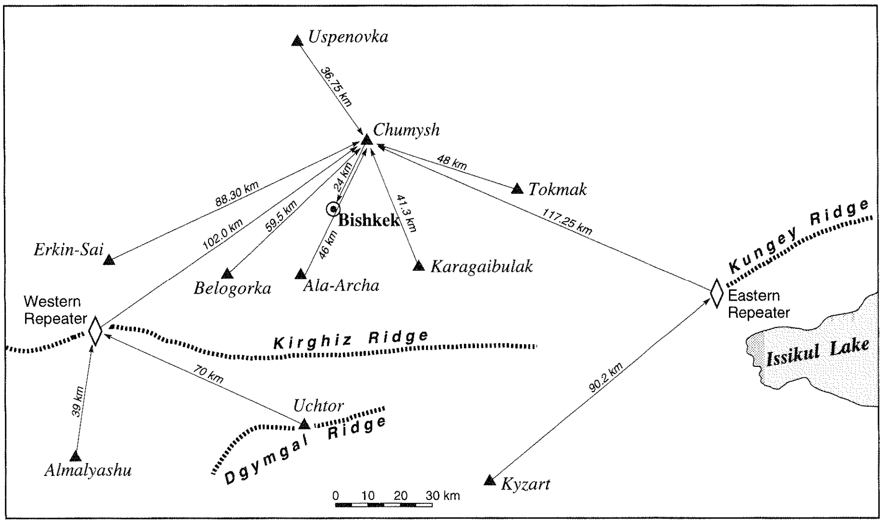

Figure 2. Station locations and telemetry used for the Kirghiz network. The central telemetry station is Chumysh. Data are recorded and processed at the Institute in Bishkek.

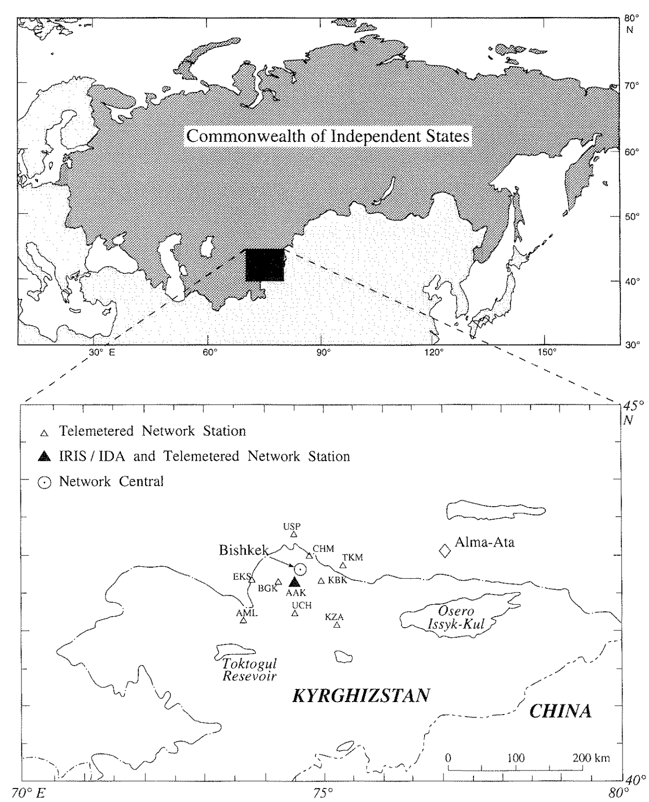

Figure 1. Location of the Kyrghizstan Seismic Telemetry Network in the newly formed Commonwealth of Independent States.

Background

The Kirghiz seismic network originated as part of the Eurasian Seismic Studies Program (ESSP) in 1989. The ESSP was a joint US-Soviet research program under the agreement on Cooperation in the Field of Environmental Protection. The US was represented by IRIS and the USGS and the Soviets were represented by the IPE. The purpose of the program was to provide facilities and data that would permit a practical understanding of seismic properties of the crust and continental lithosphere and properties of seismic sources. Part of the agreement, at Soviet request, was to install local networks in the Caucasus and Kirghizstan. During the past year the Kirghiz network has become part of the IRIS Joint Seismic Program (JSP).

A preliminary site survey was conducted and general deployment plan was developed by IPE, KIS, and UCSD during

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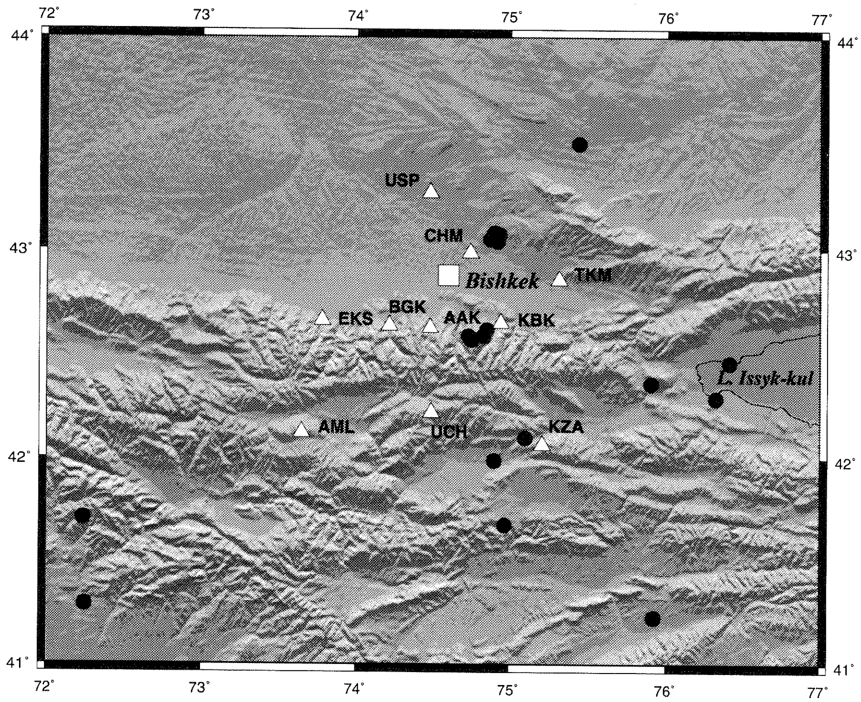

Figure 3. Epicenters of local events recorded during the first three months of network operation. Contributed by Rob Mellors, Indiana University.

1989. This was followed by a complete radio telemetry and ground noise survey for all sites during the summer of 1990 by the US and Soviet teams. The vault construction and radio licensing procedures were started by our Soviet colleagues in the later part of 1990. In parallel, all equipment was assembled and lab tested in San Diego. The final field test took place in the form of a two month deployment of a 6 kilometer aperture broadband array at Pinyon Flat in southern California. This field test, which was supported by PASSCAL, included participants from the aforementioned Soviet organizations and the following IRIS members: University of Colorado, University of South Carolina, Rennselaer Polytechnic Institute, IU and UCSD (see IRIS Newsletter, Vol. X , No. 2).

Network Design

Each seismic station consists of a Streckeisen STS-2 broadband seismometer and a Reftek RT72A datalogger with modified firmware for this telemetry application. Sensors and all electronic equipment are housed in vaults constructed by either KIS or IFTAN. Solar panels are used to power most stations. The remote stations are connected to the central receiving site at Chymush (Figure 2) with bi-directional VHF (160-170 Mhz) radio links for command and data transmission. Behind the Kirghiz ridge, which has elevations over 4800 meters, are located three sites (Uchtor, Kuzart, Almayashu) which are serviced by two repeater stations. At Chymush the data are time tagged, multiplexed and sent down a serial microwave link to the data collection center located the Kirghiz Institute of Seismology in Bishkek. Event triggering is performed by a MicroVax computer with software written by Larry Baker of the USGS.

Network Data

Three data streams are produced by this network: two 100 samples/sec streams of triggered data with gains of 36 and 0 db, and a 20 samples/sec continuous data stream with a gain of 36 db. Raw data are being archived in Bishkek, Moscow, and San Diego, and the processed data will be available through the IRIS DMC. At present, data have been received from Julian day 280 through 350 in 1991. The network is still in its shakedown phase and at present up to eight stations are being well recorded. This spring and summer the telemetry hardware and firmware will be modified so that all stations can be reliably recorded.

Research

The network is located along part of the boundary between the northern Tien Shan mountains and the Kazakh platform. Several major tectonic features are spanned by the network, including a series of thrust faults in the Tien Shan, the Chu

This Issue's Bannergram: The seismogram on the cover shows the vertical component, broadband velocity record from a M_S = 7.1 earthquake in the Himalayas on October 19, 1991 recorded at station Ala-Archa, Kirghizia (AAK, epicentral distance =1374 km). Ala-Archa is the site of one of the IRIS/IDA stations installed as part of the Joint Seismic Program and is at the center of the Kirghizstan Seismic Telemetry Network described in this issue. •

Frank Vernon, IGPP, University of California, San Diego

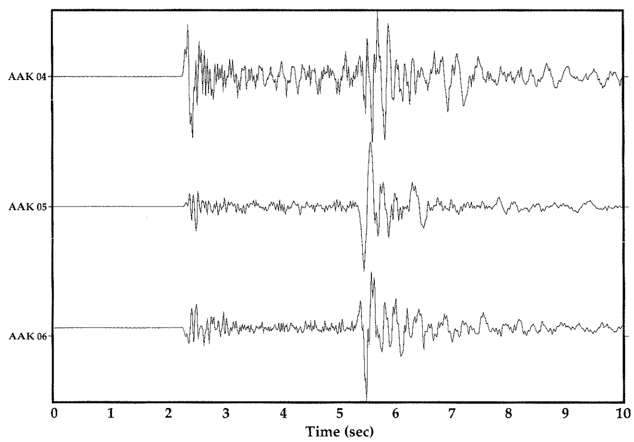

Figure 4. Three-component seismogram from a local earthquake 24km from the station at Ala-Archa.

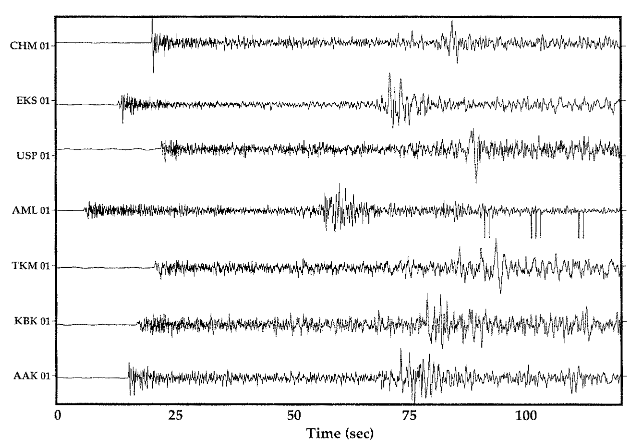

Figure 5. Vertical components from a magnitude 5.1 event located in Afghanistan on October 28, 1991, 554 km from AAK.

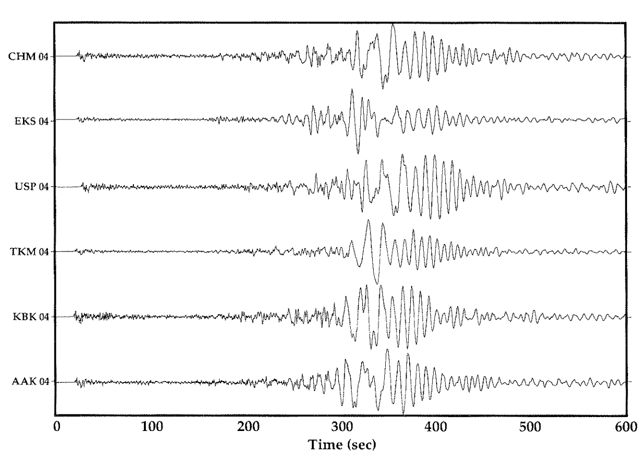

Figure 6. Vertical components from a magnitude 7.1 event located in India on October 19, 1991, 1374 km from AAK.

Valley, and the NW-SE trending ridges north of Bishkek. Historically there have been several large events in the region including two magnitude 8+ events around the turn of the century. Figure 3 shows over 20 local events recorded during the first three months of operation. Many of these events are clustered between the Ala-Archa and Karagaibulak stations. The network is located in an area Soviet scientists have hypothesized to be a seismic gap.

The geometry of the network was dictated by maximizing earthquake monitoring capability with line-of-sight telemetry constraints. Since this network was deployed with broadband sensors, it may also be used as a long-period array which will enhance signals with apparent wavelengths in the range of 10 to 100 kilometers. It is anticipated that data from this array will prove to be useful to detect small signals at long periods that would otherwise be difficult to detect.

Examples of local, regional, and teleseismic events are shown in Figures 4, 5, and 6 respectively. Proposals have been submitted from several universities to study the seismic velocity and attenuation properties of the region along with seismicity distributions to reach a better understanding of the regional tectonics. These data will also be used for research in the seismic verification of nuclear testing by analysing the high frequency seismic propagation characteristics from regional earthquake and explosion sources. The primary focus of the Soviet research will be the study of local earthquake sources and velocity structure to improve their earthquake prediction techniques. •

Operation of Garm Base Threatened

The future of the Complex Seismological Expedition at Garm is in jeopardy. This base for geopysical research, just north of the Pamir mountains in Tadjikistan, was a center for Soviet studies of earthquake prediction since it was established in the 1950's following the disastrous Khait earthquake east of Garm. With the breakup of the Soviet Union, the Garm base, operated by the Institute of Physics of the Earth of the Soviet Academy of Sciences, is being transferred to the local Tadjik Academy of Sciences. Lack of financial support, however, threatens the future operation of the base. A letter from 23 US scientists, most of whom had visited or worked in Garm, was sent to scientific and administrative leaders in Moscow and Tadjikistan to show their support for the important research done there and to express concern about the closing of the base. IRIS and the USGS are looking at to ways to help to insure the continued operation of this important facility. Anyone interested in helping to develop an expanded program of joint research in Tadjikistan can contact the IRIS office. •

Congressional Information Service from AGU and AIP

The American Institute of Physics and the American Geophysical Union are distributing very informative electronic mail postings that will be of interest to those who want to keep in touch with developments on Capitol Hill related to national science policy and the funding of federal science programs. The FYI service distributed by AIP consists of one page summaries, posted three to five times per week, with reports of Congressional hearings, information on activities of key Congressional Committees and developments related to the federal budget. The AGU Science Legislation Alert (ASLA) is similar in format, but has a greater emphasis on issues related to seismology and geophysics. ASLA is also being used to provide rapid distribution of news articles that will later appear in EOS.

To have your name added to the mailing lists, send your e-mail address to:

for FYI from AIP
fyi@pinet.aip.org

for ALCA from AGU
ASLA@kosmos.agu.org

Additional material on legislative services available from AIP can be requested electronically through fyi or by writing to:

Richard Jones
AIP
1825 Connecticut Ave, NW
Suite 213
Washington D.C. 20009.

Printed copies of past FYI releases can be obtained from the same address. •

New PASSCAL Data Available from the Data Management Center

Two new PASSCAL data sets have been delivered to the IRIS Data Management Center for distribution. The new data are from the 1990 ALOHA Experiment and the 1988 Brooks Range Experiment.

Project ALOHA (Arrays for Lithosphere Observations in Hawaii) was carried out between July, 1990 and December, 1990 to collect seismic waveform data from local and teleseismic events. The "local" portion of the project, utilizing PASSCAL instruments, was conducted by Clifford Thurber (University of Wisconsin-Madison) and Yingping Li (SUNY at Stoney Brook). The goal of this project was to use converted and reflected seismic waves to map major discontinuities in structure beneath Mauna Loa's southeast flank. Five different arrays consisting of four to six three-component digital instruments separated by 1 to 2 km in each array were operated during the experiment. In addition, a broadband ambient noise survey was conducted at five different locations with a portable broadband Guralp CMG3-ESP. The array data consist of two triggered data streams (local and teleseismic triggers) for stations with short period sensors, with an additional continuous data stream, for noise studies, at the stations with broadband sensors.

The 1988 Brooks Range Experiment was conducted by Alan Levander of Rice University in conjunction with the U.S. Geological Survey at Menlo Park. This survey was undertaken to aid in the design of the much larger experiment subsequently conducted in1990. The goals of the 1988 survey were to gather information on wave propagation, potential operational and hardware problems while obtaining a reversed wide-angle reflection/refraction profile across the Endicott Mountains Allochthon in the northern Brooks Range. A total of 10 shots were fired into the four deployments of Seismic Group Recorders (SGR III) borrowed from AMOCO Corporation, producing a reversed profile 38 km in length, and an unreversed profile extending 14 km south. The spacing of recorders was between 150 m and 450 m.

PASSCAL requires that the Principal Investigators make all data recorded with PASSCAL instruments, along with data report, available to the community through the IRIS Data Management Center within one year of the completion of the experiment. In addition to the two experiments above, data from the following experiments are also available from the Data Management Center.

1986 Basin and Range Active Source Experiment
1988 Basin and Range Passive Source Experiment
1988 Ouachita Experiment
1989 Archean-Proterozoic Transition Experiment
1989 Loma Prieta Aftershock Experiment
1990 Pinon Flats High Frequency Array

Currently, all data from PASSCAL experiments are distributed as prepackaged data sets. Interested scientist can obtain more information about the data sets and make requests for them through the IRIS Bulletin Board (see note on page 19 describing how to access the Bulletin Board). •

Jim Fowler, PASSCAL Program Manager

Coalition of Professional Associations Formed to Support NEHRP

In response to the economic and life safety threat of earthquakes in the United States, the Congress passed legislation in 1977 establishing the NEHRP, providing support for activities to achieve earthquake hazard mitigation on a national scale. NEHRP is organized at the federal level within four agencies: the Federal Emergency Management Agency as lead agency, the National Science Foundation (both Engineering and Earth Sciences), the U.S. Geological Survey, and the National Institute of Standards and Technology.

It is essential in the long term to the success of NEHRP that it be a collaboration between scientists, engineers, builders, land use planners, and government leaders. A Coalition of Professional Associations Supporting NEHRP has been formed to support the fundamental and applied research and public policy actions required to mitigate earthquake losses. The Coalition has attracted the participation of individuals who hold office in the Earthquake Engineering Research Institute, the Seismological Society of America, the American Geophysical Union (AGU), the Geological Society of America, and professional societies of engineers, architects, public administrators and city planners. AGU, and no doubt other societies, will likely be considering what activities of the Coalition it can appropriately endorse. Quoting from the Coalition's Statement of Purpose:

> "By sharing the resources of Professional Associations that span the disciplines concerned with earthquake problems, we will pursue continued, sustained funding of NEHRP to achieve the goal of loss mitigation. Although large earthquakes are rare phenomena, it is in the Nation's interest to fund this program on a continued, sustained basis, to achieve the research and applications necessary to mitigate earthquake effects. Funds spent by NEHRP on earthquake research and mitigation will be repaid many times over by reduced losses, reduced loss of tax revenues, and reduced expenditure of federal emergency and disaster relief funds associated with future earthquakes. Further, only stable support of this program will provide the education, research and technology transfer necessary so that medium and long-term progress can be achieved in reducing earthquake hazards."

It is expected that activities of individuals working within the Coalition will include the writing of a resource paper that describes: (1) the interest of professional groups associated with the Coalition in earthquake hazard reduction; (2) types of prior/current research activities undertaken in reference to earthquake hazard reduction; (3) types of future research activities needed to improve processes of earthquake hazard reduction; and (4) a rationale for continuation of the National Program. •

Paul G. Richards, President-elect
AGU Seismology Section

the IRIS CONSORTIUM

The IRIS Newsletter is published quarterly by The IRIS Consortium. Please address your letters or inquires to:

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The Incorporated Research Institutions for Seismology (IRIS) is a consortium of over 75 research institutions with major commitments to research in seismology and related fields. IRIS operates a facilities program in observational seismology and data management sponsored by the National Science Foundation. Major funding for IRIS programs is provided by the National Science Foundation through its Division of Earth Sciences and the Air Force Office of Scientific Research through Phillips Laboratory.

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.

Executive Editor: David Simpson
Production Editor: Denise Dillman-Crump

GSN Update

USGS teams completed the upgrade of the borehole site at NWAO, Narrogin, Australia on December 6, and installed GSN equipment in a new seismic vault at the South Pole (SPA) on December 22. The long period data streams from SPA will be available via satellite telemetery to the US. NWAO data will be accessible via telephone dial-up. A USGS field team completed on March 24 the installation of a new borehole GSN station at RAR, Rarotonga in the Cook Islands of the South Pacific. Preliminary measurements indicate a substantial noise reduction for the borehole recorded data relative to Streckeisen seismometers in the surface vault at RAR. The USGS team is now upgrading the SRO site at SNZO, Wellington, New Zealand.

Dr. Holly Given, who has recently been named Executive Director of IRIS/IDA program at USCD, has completed GSN site visits to Suva, Fiji; Hobart Tasmania; and Tennant Creek, Australia.

Engineering work on the Guam-Japan Undersea Cable has been completed, and tests indicate essentially no aging in the cable system since its deployment in the early 1960's.

The initial phase of deployment of the GSN, focusing on upgrading of existing stations, is nearing completion. Increasing emphasis in the future will be placed on developing new sites. The GSN Standing Committee has recently completed a review of the GSN Siting Plan, and the results of those discussions will be presented at the Workshop. •

Rhett Butler,
GSN Program Manager

STRATEGIES FOR AN EFFECTIVE PASSCAL RAPID AFTERSHOCK MOBILIZATION PLAN

Susan Y. Schwartz, University of California, Santa Cruz
and Susan L. Beck, University of Arizona

Examination of PASSCAL instrument use in 1991 reveals a year round high demand for this equipment. Several months in 1991 had all 101 available data loggers in the field. This level of involvement in field deployments by the IRIS community attests to the success of the PASSCAL program; however it also raises the question of instrument availability and readiness for rapid-response to a major earthquake. To assure instrument availability for aftershock studies IRIS is in the process of formulating a rapid aftershock mobilization plan (RAMP). Aside from the question of instrument availability, such a plan must also address the critical issues of which earthquakes merit aftershock study, how Principal Investigators will be chosen, and how financial and technical support will be provided. Here we describe two previous aftershock studies, discussing what worked and what did not work, in an attempt to help design an effective rapid aftershock mobilization plan.

1989 Loma Prieta Earthquake

The 1989 Loma Prieta earthquake provided PASSCAL instrumentation with its first opportunity to be tested in an aftershock study. Instruments were available for this deployment due to their recent return from the Greenland experiment, but had the Loma Prieta earthquake occurred one week earlier, a rapid response to this major earthquake would not have been possible. Assuring instrument availability, in the case of a major earthquake warranting study, is the first requisite of an effective aftershock plan. IRIS requested that Lamont lead the Loma Prieta aftershock deployment effort since they had extensive experience and expertise with the PASSCAL instruments. This decision allowed seismic stations to be recording aftershocks within a few days of the mainshock. Speed is a second critical element for success in most aftershock studies; however, in order to attain this speed, the initial decisions on how and where the stations would be deployed were made by a small group of people. This prevented many researchers actively working on problems relevant to this region of the San Andreas Fault from

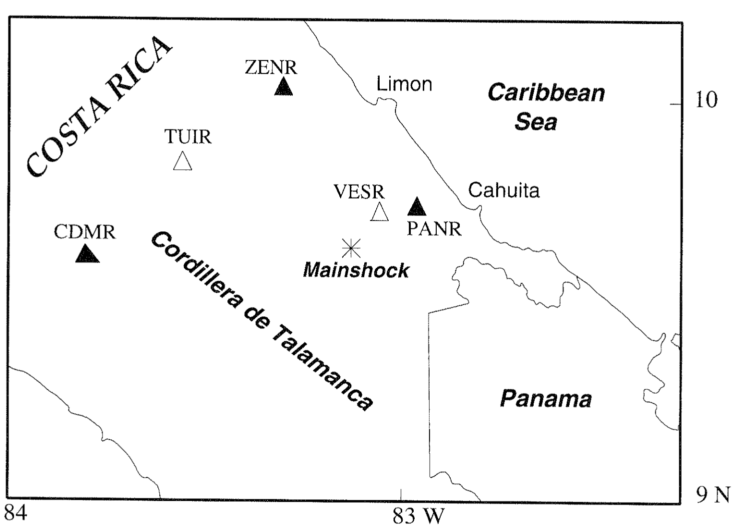


Figure 1. Mid-period (solid triangles) and short-period (open triangles) stations of our temporary Costa Rica seismic network.

participating in design of the aftershock study. Representation by as many interested scientists as possible without sacrificing too much time is a third necessary element for a successful aftershock plan.

The region of the Loma Prieta mainshock is well-instrumented by the permanent Calnet seismic array operated by the U.S. Geological Survey. For this reason, the question of whether or not a PASSCAL aftershock deployment was necessary has been raised. If the primary scientific goal of an aftershock study is to locate earthquakes, than the answer to this question is most certainly no. Clear scientific goals must be defined before an earthquake can be evaluated as a candidate for an aftershock study. Loma Prieta aftershock locations did not demonstrably improve as a result of the PASSCAL aftershock deployment; however, our understanding of realistic location errors resulting from uncertainties in velocity structure, information on the source properties of the aftershocks, knowledge of variations in the velocity structure in the vicinity of the Loma Prieta mainshock, and characterizations of local site response and near surface geology did improve. Aside from helping to constrain mainshock parameters such as faulting geometry and stress state, aftershock recordings provide valuable information about Earth structure. The high level of seismicity associated with many aftershock sequences provides a rare opportunity to collect abundant data to probe the Earth. This criteria as well as the significance of an individual earthquake and its present instrument coverage should be considered in a rapid aftershock mobilization plan. The Loma Prieta aftershock deployment is a good example of a study which produced a rich data set for investigation of Earth structure.

Figure 2. Photograph of a collapsed bridge on the road between Limon and Cahuita, Costa Rica.

1991 Costa Rica Earthquake

Following the Loma Prieta earthquake, IRIS initiated the aftershock study, assembled the Principal Investigators, and provided financial and technical assistance to carry it out. In the future, initiation of aftershock studies will more likely come from individual IRIS members and strategies to accommodate them must be established. Here we describe our experience organizing and conducting a three week aftershock study of the April 22, 1991 (Ms=7.6) Costa Rica earthquake. We hope that the difficulties, frustrations, and successes that we encountered during this experiment will help to provide some useful guidelines in constructing an effective rapid aftershock mobilization plan.

Unlike the Loma Prieta earthquake, permanent instrument coverage in the vicinity of the 1991 Costa Rica earthquake was quite sparse. This event occurred on the western edge of the Panama Deformed Belt and represented back-arc thrusting of the Caribbean plate beneath the northeast flank of the Cordillera de Talamanca (Figure 1). Large back-arc thrusting earthquakes are rare, with the last such event occurring in the Japan Sea in 1983. The unique tectonic setting of this earthquake stimulated our interest in an aftershock study. Our motivation for wanting to record aftershocks of the Costa Rica earthquake was twofold. First we were interested in more densely covering the mainshock region with seismic stations to supplement the Cost Rica network and improve aftershock locations. Second, we were interested in deploying mid-period sensors to be able to analyze aftershock waveforms for earthquake focal mechanisms and Earth structure information.

In many locations outside of the United States, logistical difficulties preclude consideration of aftershock studies for many large intriguing earthquakes. However, because of existing collaboration between the Charles F. Richter Seismological Laboratory at the University of California at Santa Cruz and the Observatorio Vulcanologico y Sismologico de Costa Rica (OVSICORI-UNA), in-country logistical support for an aftershock study of the Costa Rica earthquake was available. Unfortunately no PASSCAL data loggers were available to send with us to Costa Rica. Thanks to the Institute of Geophysics and Planetary Physics at both the University of California at San Diego and Lawrence Livermore National Laboratory we were able to acquire enough instrumentation to set-up five seismic stations. We lost almost one full week of recording time while trying to acquire seismic equipment and

continued on page 14

continued from page 13

another week waiting for NSF to respond to an emergency request for funding to support our efforts. Just short of two weeks after the earthquake, we obtained both the equipment and the money to proceed with our aftershock deployment. Further delays were encountered due to severe damage in the coastal areas which made travel very difficult (Figure 2). Our first seismic station was installed on May 6 and the network of five stations was completely operational by May 9, two and one half weeks after the mainshock. Although we were too late to record several of the largest aftershocks, we did record 43 earthquakes with M>3 and thousands of smaller events. Borrowing equipment from different organizations caused the additional problem of instrument incompatibility: recorder input parameters, handheld terminals, connection cables and exabyte tape drives were not interchangeable between stations. Establishment of a RAMP will assure that future aftershock experiments have compatible instrumentation and financial support; this will greatly reduce the delay between the occurrence of a mainshock and the recording of its aftershocks as well as reduce the number of instrument variables and insure a more successful deployment.

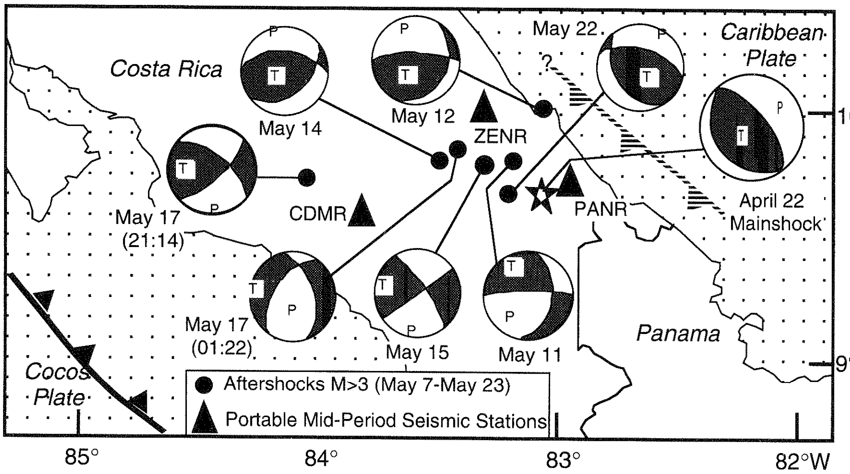


Figure 3. Map and summary of preliminary focal mechanisms for Costa Rica aftershocks determined from waveform inversion of mid-period data.

Figure 1 shows the configuration of our temporary network in Costa Rica. All stations operated three-components and consisted of Reftek 16-bit digitizers. The solid triangles indicate the stations where mid-period 5 s sensors were deployed in addition to 2-Hz geophones and the open triangles indicate stations operating high and low gain channels with 2 Hz sensors. Our station coverage is good in a 180° arc around the epicenter, more complete coverage was prevented by the rugged terrain and inaccessibility of the Cordillera de Talamanca. In general, data quality was high; the mid-period sensors provided excellent signal to noise ratios in the frequency band between 18 Hz and 8 seconds. We located hundreds of aftershocks using P and S wave arrival times from our network stations and found that the mainshock occurred on a deep (about 20 km) near-horizontal fault plane. The very shallow dip of this plane is consistent with long-period surface wave and teleseismic solutions.

This aftershock study was unique in its deployment of mid-period sensors. In addition to locating aftershocks, the broader frequency response of these sensors allowed us to invert P, SV, and SH waveforms from the larger events recorded at a single or a small number of stations for the seismic moment tensor. Although the inversion procedure requires knowledge of the source-receiver crustal structure, we found that our fault plane solutions were fairly robust to changes in the assumed crustal structure. Figure 3 shows the location and focal mechanism that we determined for this event as well as locations and mechanisms for several of the other large (M_d>3.5) aftershocks. Figure 4 shows an example of velocity records from the three mid-period stations for an aftershock on May 15 (M_d=3.8).

Our experience in Costa Rica has shown that even in less than ideal conditions it is possible to deploy mid-period sensors and record waveform data that can provide valuable information on earthquake source properties. This is very important in regions like Costa Rica where there is not a dense local network to determine reliable first motion mechanisms. We found that a few mid-period sensors can be extremely useful in determining aftershock focal mechanisms. There are tradeoffs in installing three-component high frequency geophones versus mid-period or broadband sensors. Rapid field deployments favor the simple geophones that are self contained and easy to set up. Mid-period or broadband sensors consist of three units, often need more power, are more temperature sensitive and require a flat surface to stand on. Construction of a vault or installation of a plate to house the sensors is time consuming and not always feasible. The requirements of the mid-period sensors are much less demanding than truly broadband sensors. We found that locating our stations inside of structures, where level surfaces were available and temperature fluctuations were low, made installation of the mid-period sensors no more difficult than the 2 Hz geophones. The mid-period sensors did require us to revisit sites more frequently at first, to ensure that they remained centered. After the first few days, the sensors settled and needed little further adjustment.

In summary, our aftershock deployment in Costa Rica produced a data set consisting of hundreds of events recorded by both short-period and mid-period instruments. We have been able to determine first order information such as aftershock locations and focal mechanisms. However, it is clear that we were slower than optimum in acquiring both instrumentation and financial support. Although we had help and support form many people and organizations, our deployment suffered from not having a system in place within IRIS to more effectively deal with aftershock deployment requests.

Elements of an Effective Rapid Aftershock Mobilization Plan

We envision an effective aftershock deployment plan to have the following characteristics. Immediately following an earthquake, an interested PI would make a request to the IRIS RAMP committee (ideally two-four people) for instrumentation and financial support for an aftershock study. This request would consist of a scientific and logistical plan and contain information about the technical experience of the PI. The RAMP committee must make several key decisions immediately. They must decide if the scientific plan is sound and if the earthquake merits an aftershock study. Although IRIS should provide guidelines, this evaluation will in part have to be made on an individual earthquake basis. For example, what should the policy be for earthquakes outside of the U.S.? If the first two criteria are met, the committee must then evaluate whether or not the PI is qualified to carry out the deployment and if sufficient logistical support exists. This is particularly important in evaluating potential deployments in foreign countries. These decisions should be made within 24-36 hours after the earthquake. If the decision is to support an aftershock deployment, instruments must be sent to the PI immediately and IRIS should provide a low level of funding to get the study going, with the understanding that the PI must pursue other sources of financial support to cover additional costs. One of the most difficult questions is where should the instruments come from? Ideally they should be sitting on the shelf ready to go. Of course with the present over-subscription of the PASSCAL instruments, this is not very feasible. This is a critical question that IRIS must resolve. One possible plan is to have a minimum of five instrument sets (recorders, short and mid-period sensors) reserved for aftershock deployments and have up to five additional sets made available from nearby ongoing planned experiments. This plan will be unpopular with those conducting planned experiments, however it is better than having more instruments in reserve and completely unavailable for planned experiments.

May 15, 1991, Costa Rica Aftershock, M=3.8

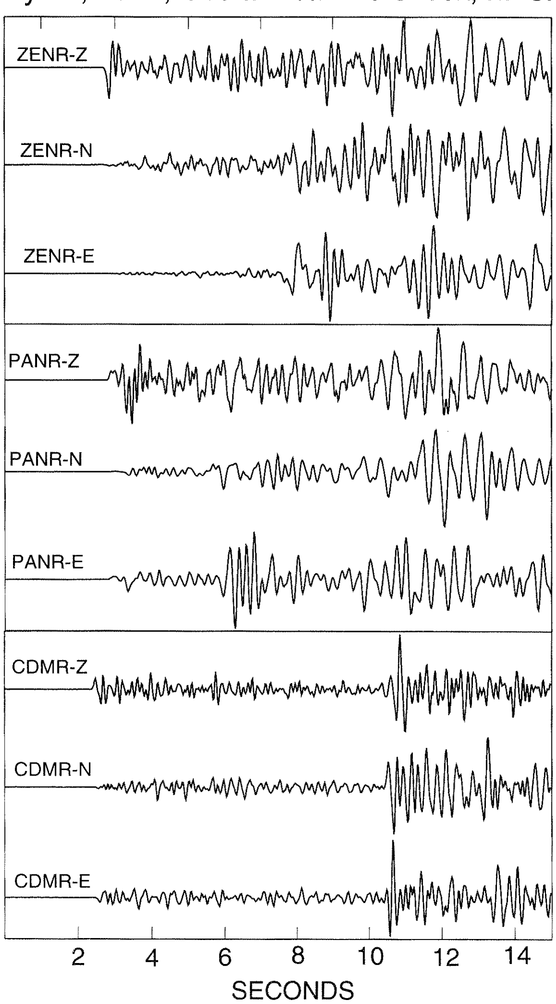


Figure 4. Vertical (Z), north-south (N), and east-west (E) velocity records for a Costa Rica aftershock recorded at the mid-period stations ZENR, PANR, and CDMR. The distances from the earthquake to these stations are 27, 36 and 69 km respectively.

Aftershock studies should be an important component of the PASSCAL program. Their success requires a well thought out plan for rapid response to major earthquakes. Here we tried to convey the importance of developing such a plan and outlined some of its significant elements. A special interest group in aftershock studies has been formed within IRIS and we invite all interested persons to participate.

Acknowledgments:

Several individuals helped to make the Costa Rica aftershock study possible. George Zandt, Aaron Velasco, Gerry Simila, Walter Schillinger, Victor Gonzales, Henry Rodriguez, Carlos Montero, and Daniel Rojas all provided field support in Costa Rica. We benefited from conversations and advise provided by George Zandt, Frank Vernon, Glenn Offield, and Larry Shengold, who freely shared with us their field instrumentation expertise. Terry Wallace and G. Fan helped with the moment tensor inversions, Federico Guendel arranged for logistical support while in Costa Rica and Karen McNally secured funding from the NSF. •

Deployment of the WWSSN 1960-1967

Jon Peterson, USGS Albuquerque Seismological Laboratory

Last October marked the 30th anniversary of the installation of the first station of the World-Wide Standardized Seismograph System, ALQ, at Albuquerque, New Mexico. It is still in operation. Last October also marked the first anniversary of the installation of the first IRIS-2 seismograph system at the same site. It is still in operation, and we trust that it will continue to produce data for the next 30 years. The deployment of the IRIS network is in full swing and commands the current interest, as it should, but perhaps we can pause momentarily to recall how things went the first time around.

The World-Wide Standardized Seismograph Network (WWSSN) was conceived in 1959 at a meeting of the Panel on Seismic Improvement, chaired by Dr. Lloyd Berkner (Oliver and Murphy, 1971). The report of this panel, entitled *The Need for Fundamental Research in Seismology*, included a recommendation to equip 100-200 stations with standard instruments and accurate clocks. The responsibility for implementing the Berkner Panel recommendations was given to the Advanced Research Projects Agency (ARPA) which organized the program under Project Vela Uniform headed by Dr. C.C. Bates. The task of deploying and operating the new global network was assigned by ARPA to the U.S. Coast and Geodetic Survey (C&GS), the principal civilian agency engaged in seismological operations. Within the C&GS, the WWSSN program was managed by L.M. Murphy, Chief of Seismology, Geophysics Division, and his assistant, R.J. Brazee. In addition to the station deployment, the program included the development and operation of a data center which had the responsibility for collection, microfilming, distribution, and archiving of WWSSN seismograms.

Following a suggestion of the Berkner Panel, the National Academy of Sciences/National Research Council established a Committee on Seismological Stations in 1960 to provide guidance in planning the new network. The Committee, chaired by Dr. J.T. Wilson, issued a report in June 1960, entitled *Specifications for a World-Wide Network of Standardized Seismographs*, that provided several broad recommendations on station siting and data management, as well as equipment specifications. Based largely on the Committee's recommendation from this 16 page report, the C&GS published performance specifications for the WWSSN instruments and issued a request for proposals in November 1960. By the end of the year responses had been received from several organizations. The contract for development and production of the WWSSN systems was awarded to the Geotechnical Corporation of Garland, Texas in early 1961. Ultimately, 127 WWSSN systems were delivered by Geotech; 121 were installed, one was given to the USSR via Lamont, and the others were used for training and maintenance.

In late 1960, the C&GS began hiring and training personnel for installation of the network. The oil industry, which was in a major recession at the time, provided most of the geophysicists hired for the program. Part of the training took place near Washington and additional training with the WWSSN instrumentation took place at the Geotech plant near Dallas. The best of facilities and equipment were not always available. The first group of installers were trained by the author in a building rented from a private kindergarten in Virginia, called Humpty Dumpty College, and some still have their diplomas to prove it.

Most organizations worldwide that had an active program or interest in seismology were offered WWSSN systems. Of those that accepted, about half were universities and the other half government agencies. No stations were installed in the Soviet-bloc countries. A few nations, including Japan and India, delayed participation in the program because it was widely and wrongly believed at the time that the WWSSN was a nuclear monitoring network. France declined to participate, which left a major network gap in French-speaking Africa.

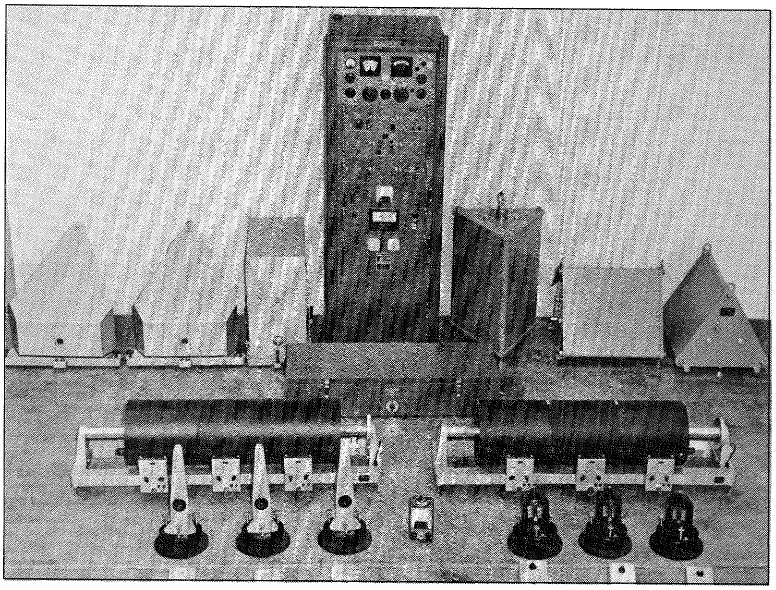


Figure 1. Photograph showing the WWSSN system. The timing and control console is shown in the center, the Sprengnether long-period seismometers on the left, the redoubtable Benioff short-period seismometers on the right, galvanometers and photographic recorders in the foreground. IRIS system installers should be thankful that seismometers have shrunk.

How much did it cost? About $9,500,000 (in 1960's dollars) for the deployment phase. The cost breakdown shown on the previous page is based to some extent on rough deduction.

The deployment of the WWSSN turned an idea into a major scientific facility in less than seven years. Indeed, most of the network and support facilities were complete within five years. The speed and relative smoothness of the operation can be attributed to effective program management, adequate funding and manpower, and the exceptional enthusiasm for the program and its benefits on the part of the participating stations and the scientific community.

Despite the early enthusiasm those five years of intense activity building the WWSSN were followed almost immediately by years of unrelenting struggle for funds to keep it operating. Therein lies an important lesson for supporters of the new IRIS network. You must maintain an interest and vigilance in the operation of the network long after the initial excitement and enthusiasm wear off. The IRIS GSN system is an outstanding replacement for the WWSSN system, and it is designed to be upgradable. With adequate support, the new network should easily match and surpass the 30-year endurance record set by the WWSSN. •

Reference: Oliver, J. and L.M. Murphy, 1971. WWNSS: Seismology's global network of observing stations. Science, vol. 174, p. 254-261.

Additions to the IRIS Staff

Corporate Office

At the head office in Arlington, Shawn Boo has recently joined IRIS as Business Manager. Shawn will be responsible for contracting and accounting, working closely with Deanna Mann. Prior to coming to IRIS, Shawn was at the Joint Oceanographic Institutions (JOI) for seven years. The pleasant voice you now hear when calling the main office is likely to be Anne DeLaBarre, who has joined as Administrative Assistant/Secretary. Over the past few months, Liz McDowell, Denise Dillman-Crump, and Anne DeLaBarre have been kept more than busy taking care of the many details related to the Workshop. In addition to arranging accommodations and travel for the Workshop, Denise has still managed to attend to the production of the Newsletter.

Data Management Center

The staff at the IRIS DMC has recently expanded. Glynis Wilson has accepted a position as a Data Control Technician (DCT) with IRIS. Her responsibilities will include archiving of all data at the DMC, processing user requests, and maintaining records of shipments. Raoul Titus has accepted a position as a half time DCT and a half time Applications Programmer. Raoul will assist Glynis in Data Management Center operations as well as performing various programming tasks. Both Glynis and Raoul are presently working at the DMC. Allen Nance has accepted a position as a Senior Programmer at the IRIS DMC. Allen will spend half of his time maintaining SEED readers and writers for the DMS and half of his time working on PASSCAL programming problems. Sue Schoch continues as the Senior Database Programmer for the DMC. Becky Wofford continues as the Systems Administrator.

The IRIS/IDA DCC has added a programmer for maintaining SEED at the IRIS/IDA DCC at the University of California at San Diego. Dave Piglowski will be working under the direction of Shane Ingate, the Director of the IDA DCC in the maintenance of DCC software.

Also a word of welcome to Sandy Stromme who has been hired by the University of Washington to support their activities as the host of the IRIS DMC. Sandy will be taking over the support of the GOPHER/BADGER data retrieval system and work on problems related to reformatting regional network data and PASSCAL data into the SEED format. •

Electronic Address for IRIS DMC

The electronic address of the IRIS DMC has been changed. Users can now use the following electronic addresses:

rlogin dmc.iris.washington.edu -l bulletin (password board)
rlogin dmc.iris.washington.edu -l gopher (password guts)

to access the Electronic Bulletin Board and the GOPHER near-real-time data retrieval system.

The Internet address for dmc.iris.washington.edu is 128.95.166.2.

The new dial in modem is (206) 547-1294.

Support for users accessing the DMC through the machine irisdmc.ig.utexas.edu will be removed at some time during the second quarter of 1992. •

CALENDAR

APRIL

12-14 **4th Annual IRIS Workshop, Santa Fe, New Mexico**

14-16 **SSA, Santa Fe, New Mexico**

MAY

11-15 **Spring AGU, Montreal, Canada**

JUNE

30 **IRIS Execom Meeting, Carnegie Institution**

JULY

6-10 **3rd SEDI Symposium, Mizusawa, Japan**

MAY 1993

3-5 **National Earthquake Conference, Memphis, Tennessee**

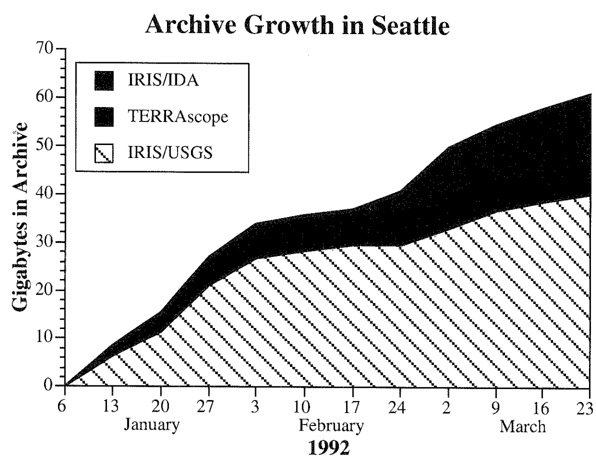
The calendar is a regular feature of the Newsletter. Please submit dates of interest to IRIS members, including meetings and field programs.

Data Archiving at the IRIS DMC in Seattle

Beginning in January, the process of transferring to the Seattle DMC all of the data presently in the Interim DMC in Austin, Texas was started. The initial months of archiving have gone fairly smoothly with the new system performing well.

As tapes are received from one of the two IRIS Data Collection Centers (DCCs), they are processed through the Data Base Management System (DBMS) developed by Sue Schoch. The parametric information that describes stations, channels and waveforms is inserted into the DBMS where users using SPROUT can access the information in the DBMS. The waveform data are removed from the incoming SEED volumes and packed into a file containing all data for a given station on a given day. These station day files are then transferred into the Metrum RSS600 mass storage system (see page 18).

Our experience in Austin showed that on average we were able to archive only about 180 megabytes of data per working day. Using the new Metrum RSS600 the IRIS DMC staff are able to completely process nearly 2 gigabytes of data per ten hour day. By late March, 1992 the new DMC had populated the DBMS and stored waveform files totaling 16553 station day files with a total size of 64.7 gigabytes.



At the present time data from three sources are being archived; 1) 42.9 gigabytes in 12977 files from the IRIS/USGS DCC, 2) 6.9 gigabytes in 842 files from the TERRAscope network, and 3) 14.9 gigabytes in 2734 files from the IRIS/IDA DCC.

The INTERIM DMC in Austin, Texas continues to archive all data and services all user requests for data. This will continue until sometime during the second quarter at which time all operations will move to Seattle. Marcie Palmer has returned to handle all duties related to the INTERIM DMC during this interim period. •

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