1995 SCEC Annual Progress Report

Portable Broadband Instrument Center

PI: Ralph J. Archuleta
Institute for Crustal Studies
University of California, Santa Barbara

Project: Portable Broadband Instrument Center (PBIC)
PI: Ralph Archuleta, *ralph@crustal.ucsb.edu*
Associates: Aaron Martin, *aaron@crustal.ucsb.edu*
Peter Rodgers, *rodgers@crustal.ucsb.edu*
Institution: Institute for Crustal Studies
University of California, Santa Barbara 93106

SCEC researchers kept the PBIC equipment in full use again this year even without the benefit of any major earthquakes. Along with acquiring data, they are actively publishing results. The reduced budget for the past year allowed only for maintenance of existing equipment. The PBIC was active in hardware and software development, response calibration and outreach programs. In addition the PBIC has implemented new procedures for correcting and tracking DAS problems as well as general quality control.

Equipment Usage

PBIC equipment was used in a variety of projects in 1995. The majority of equipment usage is accounted for between two groups: Yong-Gang Li with his series of cross-fault studies and the LA Microzonation project managed by James Chin and Jamie Steidl. The vast majority of equipment remained up and in the field the entire year.

Dates	Institution	PI(s)	Experiment
01/01/95-06/01/95	USC	Li	Landers Fault Zone
01/01/95-11/17/95	UCSB/USC	Steidl/Chin	LA Microzonation
03/25/95-06/01/95	UCSB	Lucas	Northridge Structural
05/05/95	UCSB	Archuleta/Martin	K-12 outreach presentation
05/10/95-11/17/95	UCSB	Archuleta/Steidl	GVDA Rock site
05/23/95	USGS	Fuis	Catalina Blast
05/26/95-06/10/95	USC	Abercrombie	Cajon Pass Teleseismic
05/31/95	UCSB	Kammerling/Martin	K-12 outreach presentation
06/01/95-06/15/95	USC/USGS	Li	USGS Bear Valley
06/15/95-07/30/95	USC	Li	LA Basin
06/26/95	UCSB	Watkins	Outreach
06/08/95-08/02/95	USC	Robertson/Smith	LABNet Calibration
08/01/95-11/17/95	USC	Li	San Jacinto Fault Zone

SCEC Research Using PBIC Equipment

Yong-Gang Li used three SCEC PBIC refteks to supplement network data in his 1992-1995 LA Basin experiment investigating shear-wave splitting. Some of the main findings of his research show that: 1) The preferred polarization of the fast shear-wave is either nearly N-S, consistent with the direction of the regional maximum horizontal compressive stress, or in the strike direction of local faults; 2) The split increases as the

travel distance increases within the shear-wave window; 3) Shear-wave splitting of 2.8 to 7.8 ms/km can be explained in terms of an anisotropic crust containing vertical cracks with a crack density of 0.023 to 0.080. A paper on this research has been submitted to the USGS and JGR.

Ryan Smith, a SCEC summer intern working under Michelle Robertson, used the calibration technique developed at the PBIC to calibrate the sensors in the USC LA Basin seismic Network (LABNet). The collected information identified several problems and will provide a means of removing the instrument response from past data. Some of these findings were presented by Ryan at the 1995 SCEC Annual meeting. The PBIC provided additional technical information for his final report to SCEC. In addition, information from the report will be distributed to institutions that use LABNet data.

Gary Fuis was able to successfully organize a short notice follow-up project to the LARSE 94 experiment by deploying several stations to record a large quarry blast on Catalina Island. The stations were deployed along Line 1 of the LARSE 94 project. The collected information should provide supplemental timing and imaging information for the LARSE 94 processing teams.

Jamie Steidl is using a single station deployed at a rock site near the Garner Valley Downhole Array (GVDA) as a reference site for some comparisons of wave propagation in the valley. This site is used to evaluate the site response associated with rock sites that would be considered typical "reference" sites in site-specific hazard analysis studies. Dr. Steidl is also using the data to evaluate non-reference site techniques in estimating site response in a region where the true site response is known from extensive downhole instrumentation and geotechnical data.

The cooperative LA Microzonation experiment managed by James Chin and Jamie Steidl continues to collect data in the LA Basin. This five station array was supplemented with ten sites of PASSCAL equipment for six months in 1995. Analysis of the data collected from Northridge aftershocks shows evidence that coda-wave amplification factors are larger than S-wave amplification factors at basin sites.

Robert Lucas, an undergrad at UCSB, deployed one station to investigate wave propagation near structures in Northridge. He is currently writing up his analysis of the data he collected along with some Northridge aftershock data from the SCEC data center.

PBIC equipment was used in several outreach demonstrations for local organizations. For two different elementary school presentations, the PBIC made short recordings of student's stomps and was able to produce a personalized plot for each student as well as a large versatec plot of the entire demonstration for the classroom. These presentations were received enthusiastically. Undergraduates in the Geological Sciences Department at UCSB used PBIC equipment in several more community demonstrations. The PBIC set up a DAS and computer system for the Santa Barbara Earthquake Fair on the UCSB campus. The PBIC was minimally involved with a SCEC educational program that established CUBE systems at three local schools. The PBIC is assisting in the establishment of three CUBE stations on the UCSB campus. The PBIC produced a three page article that was published in the SCEC Summer quarter newsletter.

Sensor Calibration

The sensor calibration procedure developed by the PBIC was used by a SCEC intern to calibrate the USC managed LA Basin seismic Network (LABNet). The

calibration procedure and software was refined during this process. Most of the procedure was done using tools constructed from the tcl/tk toolset.

Hardware: Management, Development, Repair and Quality Control

The PBIC has developed some quality assurance procedures in response to the increasing age and maintenance requirements of the hardware. The procedures will allow better tracking of equipment problems, repairs and chronic failures. Twenty-six such problem reports have been filed and resolved in the past year.

The PBIC has been more involved in hardware development over the last few years. A smaller, less expensive power supply for the more modern SCSI hardware was developed to provide an alternative to the larger Reftek power supply. This power supply prototype is installed in one of the 1Gb data transfer disks. A second generation of response calibration box has been developed. The new prototype is designed specifically to work with Reftek DASs and sensors terminated with the U77 style connectors and minimizes the number of external cables required for calibration.

The PBIC has continued to provide Reftek maintenance services to SCEC member institutions (UCLA, Caltech, USC, CSUN) over the past several years. Services include firmware upgrades and quality assurance testing.

The PBIC tests new equipment as it becomes available to insure that SCEC researchers have modern equipment. This past year, the PBIC evaluated the Guralp CMG40-T as a possible mid-range seismometer and the Texas Components 24 bit, low noise (1 count) analog-to-digital converter.

Software and computational support

The increasing popularity and access to the World Wide Web has prompted the PBIC to expand its Web page. The PBIC home page has been accessed 379 times by 234 users in the last 5 months. Future Web development will enhance this page as an on-line reference for PBIC activities and procedures. Timeline conversion into Web format has been somewhat automated. The hope is to add more graphics that indicate status of other equipment such as sensors.

Most of the continued development on the response software is the expansion of the GUI tools used to control the procedures. Observations made during our numerous uses of the response software are leading to an investigation into the response behavior of tilted seismometers by the PBIC. The PBIC will be investigating some of the non-linearities exhibited in tilted seismometers. The hope is that the errors and how data are affected can be quantified and understood. Peter Rodgers is currently investigating the mathematics and theory in preparation for some controlled experimentation.

There is continued development in the area of fixing Reftek problems. A recently released piece of PASSCAL software caused the discovery of a Reftek bug that may have existed for some time. The problem shows up as a sequence error in the new PASSCAL code. Sequence checking was not done previously. It is believed that in the past, these same errors would have shown up as a timing shift that would be corrected a short time later. Investigation of the problem indicates that the problem originates in the DAS and occurs intermittently during auto dumps during recording. The PBIC created a csh that uses existing utilities to correct many cases of this problem. A more complete investigation of the problem is still underway.

Publications

Due to the wide distribution of the SCEC's earthquake data sets, such as Northridge and Landers, we will not attempt to list publications using those expansive data sets. Publications by the PBIC and researchers directly using the equipment will be listed.

Aki, K. and B-H. Chin, "The Use of Coda Waves for Characterizing the Site Effect on Strong Ground Motion, Proc. Structure Congress XII, ASCE, Vol. 1, 579-584.Rodgers, P., Martin, A., Robertson, M., Hsu, M., Harris, D., "Signal Coil Calibration of Electro-Magnetic Seismometers," published in the *Bulletin of the Seismological Society of America.*, Vol. 85, No. 3, pp. 845-850, June 1995.

Edelman A., F. Vernon. "The Northridge Portable Instrument Aftershock Data Set Data Product Report", SCEC. May 30, 1995.

Li, Y.-G, K. Aki, D. Adams, A. Hasemi and W. H. K. Lee, Seismic guided waves trapped in the fault zone of the Landers, California, earthquake of 1992, *Journal of Geophysical Research.*, 99, 11705-11725, 1974a.

Li, Y.-G., J. E. Vidale, K. Aki, C. Marone and W. H. K. Lee, Fine structure of the Landers fault zone; segmentation and the rupture process, *Science*, 256, 367-370, 1994b.

Li, Y.-G., K. Aki, W. L. Ellsworth and C. H. Thurber, Observations of fault zone trapped waves excited by explosions at the San Andreas fault, central California, *Bulletin of the Seismological Society of America.*, in review, 1995.

Li, Y.-G., Shear-wave splitting observations and implications on stress regimes in the Los Angeles basin, California, *Journal of Geophysical Research.*, in review, 1995.

Martin, A., P. Rodgers and R. J. Archuleta, "The Portable Broadband Instrument Center (PBIC)," published in the *SCEC Quarterly Newsletter*, Vol 1, Number 2, pp 6,8-9, Summer 1995.

Steidl, J. H., F. Bonilla, and A. G. Tumarkin (1995). Seismic hazard in the San Fernando basin, Los Angeles, California: A site effects study using weak-motion and strong-motion data, *Proceedings of the fifth International Conference on Seismic Zonation*, Ouest Editions, Presses Academiques.

Steidl, J. H., A. G. Tumarkin and R. J. Archuleta (1995). What is a reference site? *Bulletin of the Seismological Society of America*, in press.