

(see AD# A260039 - Semi-Ann. Rpt #1)

TGAL-92-14

## DEVELOP AN X-WINDOWS TOOL TO COMPUTE GAUSSIAN BEAM SYNTHETIC SEISMOGRAMS

J. Peter Davis and Ivan H. Henson

Teledyne Geotech Alexandria Laboratories  
314 Montgomery Street  
Alexandria, Virginia 22314-1581

OCTOBER 1992

SEMI-ANNUAL REPORT:	No. 2 ( 5 April 1992 - 23 August 1992 )
ARPA ORDER NO.:	6731
PROJECT TITLE:	X-Windows Tool to Compute Gaussian Beam Synthetic Seismograms
CONTRACT NO.:	F29601-91-C-DB04

Approved for Public Release; Distribution Unlimited

Prepared for:  
PHILLIPS LABORATORY  
KIRTLAND AFB, NM 87117-5320

Monitored by:  
DEFENSE ADVANCED RESEARCH PROJECTS AGENCY  
NUCLEAR MONITORING RESEARCH OFFICE  
3701 NORTH FAIRFAX DRIVE  
ARLINGTON, VA 22203-1714

The views and conclusions contained in this report are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of the Defense Advanced Research Projects Agency or the U.S. Government.

**DTIC QUALITY INSPECTED 1**

19990316 066

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE 23 August 1992	3. REPORT TYPE AND DATES COVERED Technical Report, 5 Apr 1992 - 23 Aug 1992		
4. TITLE AND SUBTITLE Develop an X-Windows Tool to Compute Gaussian Beam Synthetic Seismograms			5. FUNDING NUMBERS Contract F29601-91-C-DB04	
6. AUTHOR(S) J. Peter Davis and Ivan H. Henson				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Teledyne Geotech Alexandria Laboratory 314 Montgomery Street Alexandria, VA 22314-1581			8. PERFORMING ORGANIZATION REPORT NUMBER TGAL-92-14	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Phillips Laboratory (PL/PKRC) Kirtland AFB, NM 87117-5320			10. SPONSORING/MONITORING AGENCY REPORT NUMBER DARPA-NMRO 3701 N. Fairfax Drive #717 Arlington, VA 22203-1714	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for Public Release; Distribution Unlimited			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) <p>This report contains a description of progress made on the design of an X-Windows package for computing synthetic seismograms using the Gaussian Beam method. A summary of the functional flow and the basic architecture of the system formed the bulk of the first semiannual report for this project. Development has now reached the point that the user can create synthetic seismograms for two-dimensional velocity models created with the X-Windows interface. A module called Xgb is used to form and shape the two-dimensional velocity models and to trace rays through the medium. A second module, called GBseis, reads the raytracing results created by Xgb and computes synthetic seismograms according to instructions passed to it via interprocess communication (IPC) messages from Xgb. The IPC software and the code to view the results of the synthetic seismogram computation have all been developed previously under the NMRD. A final major step yet to be done is to incorporate SQL queries into the code to allow raytracing results and velocity models to be stored within an Oracle database like that which exists within the software environment at the Center for Seismic Studies.</p>				
14. SUBJECT TERMS Gaussian Beams, Synthetic Seismograms, X-Windows tools			15. NUMBER OF PAGES 19	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL	

Table of Contents

Table of Contents ..... i

1. Objectives ..... 1

2. Current State of Development ..... 1

3. Post-Tucson Improvements ..... 5

4. Remaining Tasks ..... 6

5. References ..... 6

6. Distribution List ..... 7

## 1. OBJECTIVES

The principal objective of this project is to create an X-Windows-based graphics tool to compute rapidly and efficiently, synthetic seismograms for laterally heterogeneous, two-dimensional, isotropic velocity models using the Gaussian beam method. The existing Gaussian beam software is written in Fortran code and can be very labor intensive to use. Our goal is to construct an X-Windows Graphical User Interface (GUI) which will eliminate much of the tedium of introducing lateral heterogeneity into two-dimensional velocity models.

This report contains a description of progress made on the design during the past six months. A summary of the functional flow and the basic architecture of the system formed the bulk of the first semiannual report for this project. Included here is a list of what remains to be done before completion.

## 2. CURRENT STATE OF DEVELOPMENT

During the past six months, the two programs which constitute a new system to compute synthetic seismograms have undergone rapid development. *Xgb*, the X-Window interface, is now fully capable of displaying velocity models in two dimensions, allowing the user to modify those models through graphical tools, and tracing rays through the velocity model for later use in seismogram computation or traveltimes queries. *Xgb* exchanges information via interprocess communication (IPC) messages with a second module, *GBseis*, that actually performs the seismogram computation and responds to traveltimes queries. *Xgb* also exchanges IPC messages with *geotool* that allows the user to set the channels, time scale and origin parameters to be synthesized. A working version of this package was demonstrated at the 14th Annual Phillips Lab/DARPA Symposium Sept 16-18, 1992, in Tucson.

One way of outlining the current capabilities is to describe how a typical *Xgb* session would proceed. The user initiates the program *Xgb* to construct a 2-D velocity model or read in one already created in an earlier session. The former case is illustrated here. The user presses a button, and the display shown in Figure 1 appears. A number of regional and global 1-D starting models are available from which the user may choose. The 1-D global model selection *jb* (for Jeffreys-Bullen) is highlighted in inverse video, and  $v_p$ ,  $v_s$ , and  $\rho$  appropriate for JB are plotted on the right. Once a model is selected, the graphs of  $v_p$ ,  $v_s$  and  $\rho$  are updated accordingly. The vertical dimension of the space to be modeled extends from the free surface to a depth controlled by the horizontal line segment shown on each of the three functions. The line may be slid vertically by the mouse or, alternatively, the bottom depth may be entered into the space labeled "Depth" at the lower left. By setting a minimum lower depth and the number of horizontal knots (at the lower right), one can control model size and therefore performance speed. The breadth of the model is controlled by entering the maximum number of degrees (or kilometers for regional models) in the bottom center window.

Figure 2 shows the result of specifying the starting model of Figure 1, placing a source at 350 km depth, and then plotting rays for  $P$ ,  $pP$  and  $PcP$ . Symbols representing

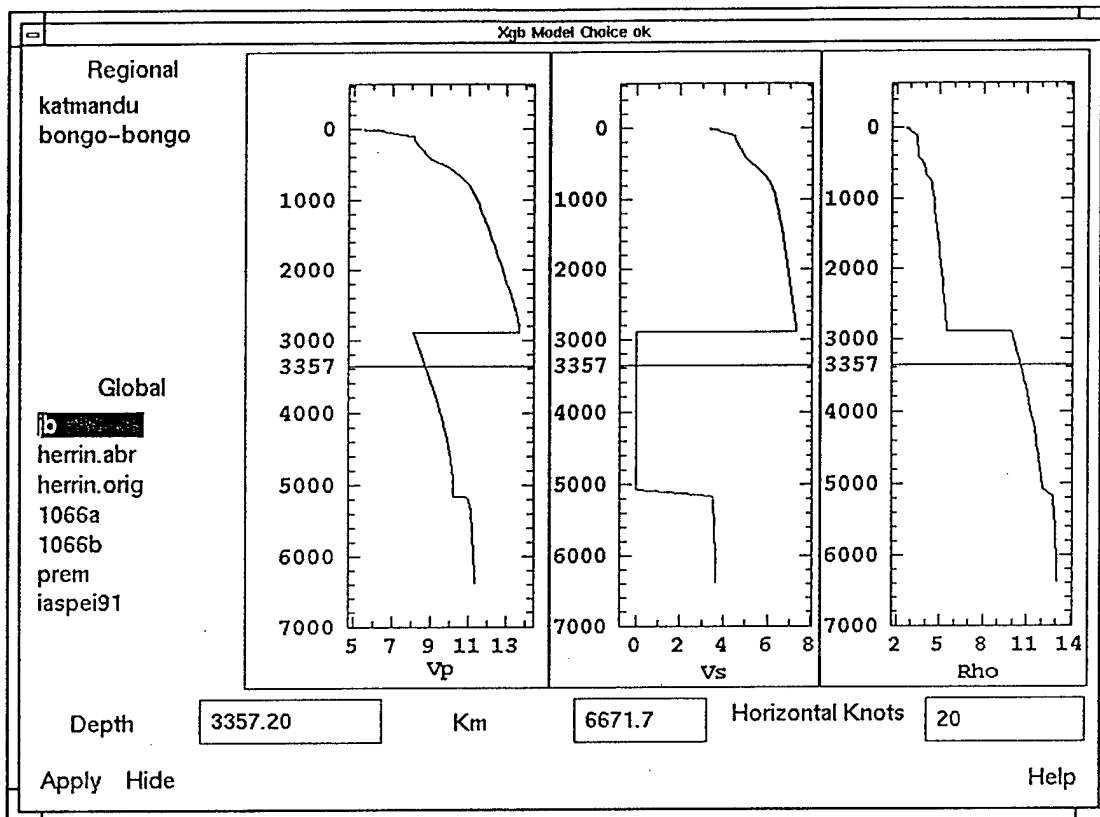


Figure 1

the position of two receivers at  $x=4000$  and  $x=4200$  km respectively can just be seen. The results of dynamic raytracing have been preserved for later use by *GBseis* in a disk file. Should the user now wish to alter the model, this may be accomplished by "grabbing" a knotpoint at the vertices of the model triangles and translating it through space. Because velocity is linearly interpolated between model knotpoints, this translation changes the velocity gradient in all adjacent triangles. After the model is altered, rays are rapidly retraced through the new model.

Having completed the raytracing, the user initiates seismogram computation with the *Xgb* window pictured in Figure 3. There are a number of buttons in this window which allow the user to adjust the parameters used in seismogram computation. Elements in the upper left control how Gaussian beams will be summed by *GBseis* and what type of source will be employed. Epsilon, the Gaussian beam parameter, allows the user to alter how the program sets or computes the widths of the beams. The numbering scheme followed here is governed by the convention outlined in *Weber* (1988). The user has a choice of treating the medium as elastic or taking attenuation into account. The toggle is here set to the anelastic case. Finally for source type, one may choose between a point

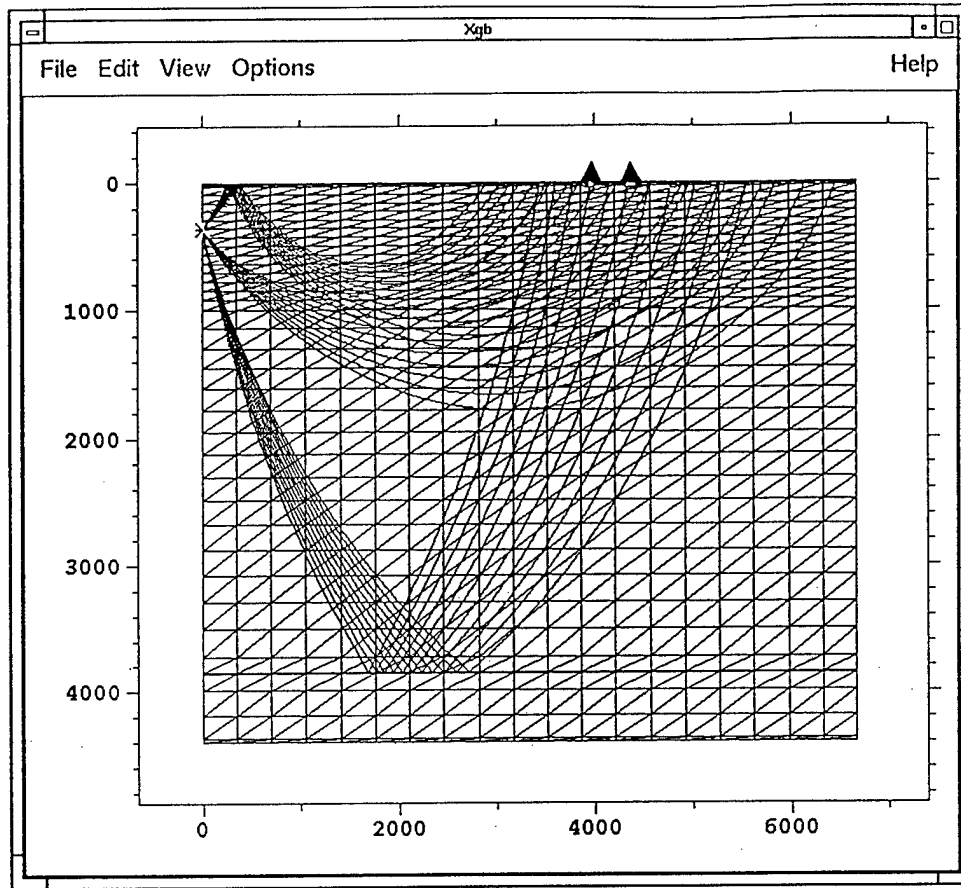


Figure 2

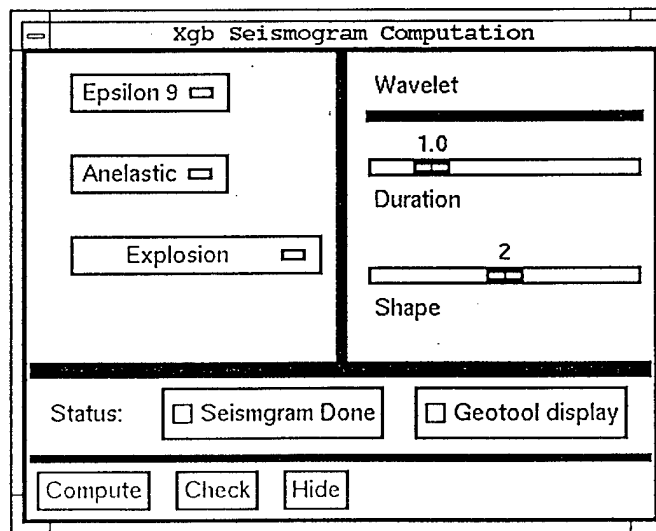


Figure 3

source (explosion), line source, or double couple. If the latter, the user may adjust the focal mechanism orientation through a popup containing sliders. On the right are sliders which control the source-time function. At this stage of development, the only source-time function used by the program is the Küpper signal defined by its period (duration) and number of zero crossings (shape).

Once the user has chosen the parameters, he pushes the "Compute" button at the bottom, and an IPC message containing these parameters is sent to *GBseis*, which has been running quietly in background all of this time. *GBseis* performs the computation, writes the results onto disk in CSS 3.0 format, and returns an IPC message to *Xgb* informing it that the computation is complete, or if an error has occurred, what that error was. If successful, *Xgb* sends a different message to *geotool* informing it where the waveform files are located on disk. Otherwise, *Xgb* brings up a text window containing a terse explanation of why the computation failed.

Figure 4 illustrates a *geotool* display in response to receiving an IPC message from *Xgb*. The three phases are plainly visible on both the vertical and radial components for both stations. Should the user wish to change the wavelet shape or source type, he need only adjust the display in Figure 3 and depress the "Compute" button once again. The time required to exchange IPC messages, compute the seismograms, and display the results is on the order of 10s or less.

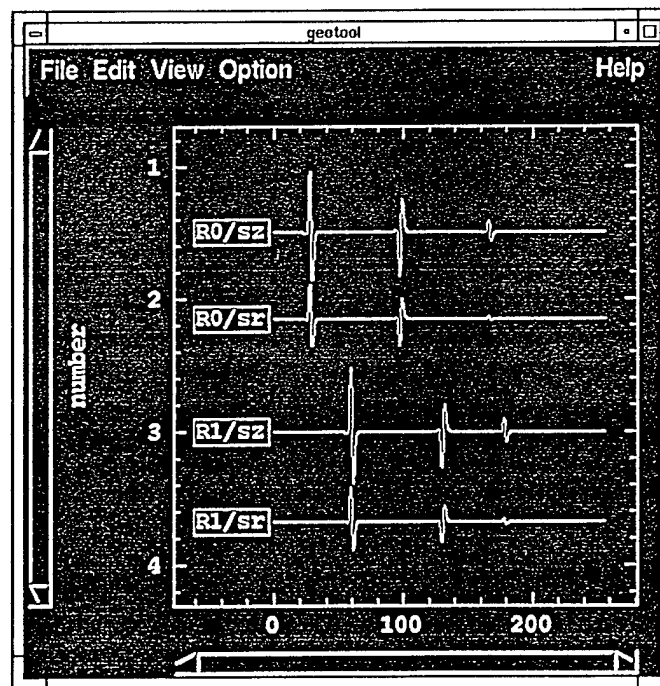


Figure 4

### 3. POST-TUCSON IMPROVEMENTS

Two of the shortcomings evident in the version showed at the Tucson meeting have been addressed since that time. The user may now input a source-time function from a file and substitute it for the Küpper signal used previously. The graphics of Figure 3 are being updated to reflect this change.

More importantly, selection of phases to include in the seismogram is now much easier than before. Figure 5 illustrates the selection list now available to the user. To include a phase, it is only necessary to click on its name in the list. Not apparent from this illustration is the use of color in the actual display. Legs of rays run as *P* or *S* waves are shown in contrasting red or blue.

Less apparent at Tucson was *GBseis*'s inability to generate a transverse trace. This has been addressed in the *GBseis* code, but there remain some refinements in the way *Xgb* records the raytracing results before this capability is fully realized.

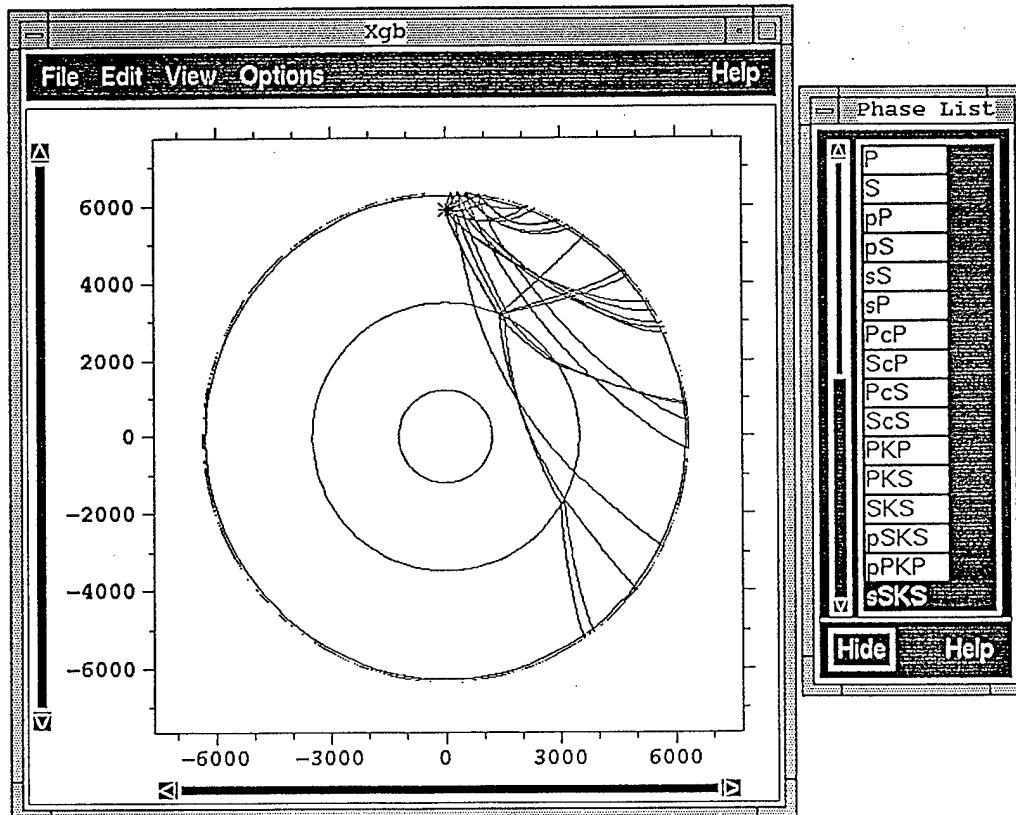


Figure 5

#### 4. REMAINING TASKS

The chief software engineering task which remains is to embed SQL queries within the C code. It is our intention to build the model lists in the window of Figure 1 by referring to information stored in the CSS Oracle database. Likewise, we wish to store the locations of 2-D models and the raytracing results corresponding to these models in the database for future reference by researchers of the IMS. Because some high-level routines for accomplishing just these tasks have already been created through the NMRD, this is not a daunting task, but as in all programming, it will require paying attention to detail.

As time permits, we will work further on that part of *Xgb* which allows the user to manipulate the model. There is a clear need to let the user modify the velocity *at a knotpoint* rather than simply allowing him to translate the knotpoint through space. Also, one would wish to alter the properties of groups of knotpoints.

Considerable progress has been made in porting the code to Teledyne's new IRIS Crimson Elan machine. The software development tools provided with the Crimson should accelerate the remainder of work to be done for this project.

#### 5. REFERENCE

Weber, M. (1988), Computation of body-wave seismograms in absorbing 2-D media using the Gaussian beam method: comparison with exact methods, *Geophys. J.*, **92**, 9-24.

NON-GOVERNMENT CONTRACTORS

Prof. Thomas Ahrens  
Seismological Lab, 252-21  
Div. of Geol. & Planetary Sciences  
California Institute of Technology  
Pasadena, CA 91125

Michael Browne  
Teledyne Geotech  
3401 Shiloh Road  
Garland, TX 75041

Dr. Thomas C. Bache, Jr.  
Dr. Thomas J. Serena, Jr.  
Science Applications Int'l Corp.  
10260 Campus Point Drive  
San Diego, CA 92121  
(2 copies)

Dr. Lawrence J. Burdick  
Woodward-Clyde Consultants  
566 El Dorado Street  
Pasadena, CA 91109-3245

Dr. Peter Basham  
Dr. Robert North  
Earth Physics Branch  
Geological Survey of Canada  
1 Observatory Crescent  
Ottawa, Ontario, CANADA K1A 0Y3

Dr. Theodore Cherry  
Science Horizons, Inc.  
710 Encinitas Blvd., Suite 200  
Encinitas, CA 92024 (2 copies)

Dr. Douglas R. Baumgardt  
Dr. Zoltan Daz  
ENSCO, Inc.  
5400 Port Royal Road  
Springfield, VA 22151-2388

Dr. Kin Yip Chun  
Geophysics Division  
Physics Department  
University of Toronto  
Ontario, CANADA M5S 1A7

Prof. Jonathan Berger  
IGPP, A-025  
Scripps Institution of Oceanography  
University of California, San Diego  
La Jolla, CA 92093

Dr. Paul M. Davis  
Dept. Earth & Space Sciences  
University of California (UCLA)  
Los Angeles, CA 90024

Dr. G. A. Bollinger  
Department of Geological Sciences  
Virginia Polytechnic Institute  
21044 Derring Hall  
Blacksburg, VA 24061

Prof. Steven Day  
Department of Geological Sciences  
San Diego State University  
San Diego, CA 92182

Ms. Eva Johannisson  
Senior Research Officer  
National Defense Research Institute  
P.O. Box 27322  
S-102 54 Stockholm, SWEDEN

The Librarian  
Dr. Jerry Carter  
Dr. Stephen Bratt  
Center for Seismic Studies  
1300 North 17th Street, Suite 1450  
Arlington, VA 22209-2308  
(3 copies)

Dr. Mark D. Fisk  
Mission Research Corporation  
735 State Street  
P.O. Drawer 719  
Santa Barbara, CA 93102

Prof. Stanley Flatte  
Applied Sciences Building  
University of California  
Santa Cruz, CA 95064

Robert C. Kemerait  
ENSCO, Inc.  
445 Pineda Court  
Melbourne, FL 32940

Dr. Roger Fritzel  
Pacific Sierra Research  
1401 Wilson Blvd., Suite 1100  
Arlington, VA 22209

Prof. Brian L. N. Kennett  
Research School of Earth Sciences  
Institute of Advanced Studies  
G.P.O. Box 4  
Canberra 2601, AUSTRALIA

Dr. Holly K. Given  
Inst. Geophys. & Planet. Phys.  
Scripps Inst. Oceanography (A-025)  
University of California-San Diego  
La Jolla, CA 92093

Dr. Richard LaCoss  
MIT-Lincoln Laboratory  
M-200B  
P.O. Box 73  
Lexington, MA 02173-0073

Prof. Hans-Peter Harjes  
Institute for Geophysics  
Ruhr University/Bochum  
P.O. Box 102148  
4630 Bochum 1, FRG

Prof. Fred K. Lamb  
Univ. of Illinois  
Department of Physics  
1110 West Green Street  
Urbana, IL 61801

Prof. Donald V. HelMBERGER  
Seismological Laboratory  
Div. of Geol. & Planetary Sciences  
California Institute of Technology  
Pasadena, CA 91125

Prof. Charles A. Langston  
Geosciences Department  
403 Deike Building  
The Pennsylvania State University  
University Park, PA 16802

Prof. Eugene Herrin  
Prof. Brian Stump  
Inst. for the Study of Earth and Man  
Geophysical Laboratory  
Southern Methodist University  
Dallas, TX 75275

Prof. Thorne Lay  
Dr. Susan Schwartz  
Institute of Tectonics  
Earth Science Board  
University of California, Santa Cruz  
Santa Cruz, CA 95064

Prof. Bryan Isacks  
Prof. Muawia Barazangi  
Cornell University  
Department of Geological Sciences  
SNEE Hall  
Ithaca, NY 14850

Prof. Arthur Lerner-Lam  
Prof. Paul Richards  
Prof. C. H. Scholz  
Lamont-Doherty Geol. Observatory  
of Columbia University  
Palisades, NY 10964

Prof. Lane R. Johnson  
Prof. Thomas V. McEvilly  
Seismographic Station  
University of California  
Berkeley, CA 94720

Dr. Manfred Henger  
Fed. Inst. for Geosci. & Nat'l Res.  
Postfach 510153  
D-3000 Hanover 51, FRG

Dr. Peter Marshall  
Procurement Executive  
Ministry of Defense  
Blacknest, Brimpton  
Reading FG7-4RS, UNITED KINGDOM

Mr. Jack Murphy  
S-CUBED  
11800 Sunrise Valley Drive  
Suite 1212  
Reston, VA 22091  
(2 copies)

Dr. Randolph Martin, III  
New England Research, Inc.  
76 Olcott Drive  
White River Junction, VT 05001

Dr. Jay J. Pulli  
Radix Systems, Inc.  
2 Taft Court, Suite 203  
Rockville, MD 20850

Dr. Bernard Massinon  
Societe Radiomana  
27 rue Claude Bernard  
75005 Paris, FRANCE (2 copies)

Dr. Frode Ringdal  
Dr. Svein Mykkeltveit  
NTNF/NORSAR  
P.O. Box 51  
N-2007 Kjeller, NORWAY  
(2 copies)

Dr. Gary McCartor  
Prof. Henry L. Gray  
Department of Physics  
Southern Methodist University  
Dallas, TX 75275

Dr. Wilmer Rivers  
Teledyne Geotech  
314 Montgomery Street  
Alexandria, VA 22314  
(2 copies)

Dr. Keith L. McLaughlin  
S-CUBED  
P.O. Box 1620  
La Jolla, CA 92038-1620

Dr. Richard Sailor  
TASC, Inc.  
55 Walkers Brook Drive  
Reading, MA 01867

Dr. Pierre Mecheler  
Societe Radiomana  
27 rue Claude Bernard  
75005 Paris, FRANCE

Prof. Charles G. Sammis  
Prof. Kei Aki  
Center for Earth Sciences  
University of Southern California  
University Park  
Los Angeles, CA 90089-0741

Prof. Bernard Minster  
Prof. John Orcutt  
Dr. Holly Given  
IGPP, A-025  
Scripps Institute of Oceanography  
University of California, San Diego  
La Jolla, CA 92093

Prof. David G. Simpson  
Lamont-Doherty Geological Observatory  
of Columbia University  
Palisades, NY 10964

Prof. Brian J. Mitchell  
Dr. Robert Herrmann  
Dept of Earth & Atmospheric Sciences  
St. Louis University  
St. Louis, MO 63156

Dr. Stewart W. Smith  
Geophysics AK-50  
University of Washington  
Seattle, WA 98195

Prof. Clifford Thurber  
 Prof. Robert P. Meyer  
 University of Wisconsin-Madison  
 Department of Geology & Geophysics  
 1215 West Dayton Street  
 Madison, WI 53706

Prof. M. Nafi Toksoz  
 Prof. Anton Dainty  
 Earth Resources Lab  
 Mass. Institute of Technology  
 42 Carleton Street  
 Cambridge, MA 02142

Prof. Terry C. Wallace  
 Department of Geosciences  
 Building #77  
 University of Arizona  
 Tucson, AZ 85721

Dr. William Wortman  
 Mission Research Corporation  
 735 State Street  
 P.O. Drawer 719  
 Santa Barbara, CA 93102

U.S. GOVERNMENT AGENCIES

Mr. Alfred Lieberman  
 ACDA/VI-OA, Room 5726  
 320 21st Street, N.W.  
 Washington, DC 20451

Colonel Jerry J. Perrizo  
 AFOSR/NP, Building 410  
 Bolling AFB  
 Washington, DC 20331-6448

Dr. Robert Blandford  
 AFTAC/CSS  
 1300 No. 17th St., Suite 1450  
 Arlington, VA 22209

AFTAC/CA  
 (STINFO)  
 Patrick AFB, FL 32925-6001

Dr. Frank F. Pilotte  
 HQ AFTAC/TT  
 Patrick AFB, FL 32925-6001

Katie Poley  
 CIA-ACIS/TMC  
 Room 4X16NHB  
 Washington, DC 20505

Dr. Larry Turnbull  
 CIA-OSWR/NED  
 Washington, DC 20505

Dr. Ralph W. Alewine, III  
 Dr. Alan S. Ryall, Jr.  
 Ms. Ann U. Kerr  
 DARPA/NMRO  
 1400 Wilson Blvd.  
 Arlington, VA 22209-2308  
(7 copies)

DARPA/OASB/Librarian  
 1400 Wilson Blvd.  
 Arlington, VA 22209-2308

Dr. Dale Glover  
 DIA/DT-1B  
 Washington, DC 20301

Dr. Michael Shore  
 Defense Nuclear Agency/SPSS  
 6801 Telegraph Road  
 Alexandria, VA 22310

Dr. Max Koontz  
 U.S. Dept of Energy/DP-5  
 Forrestal Building  
 1000 Independence Avenue  
 Washington, DC 20585

Defense Technical Information Center  
 Cameron Station  
 Alexandria, VA 22314 (2 copies)

Dr. John J. Cipar, PL/LW  
 Phillips Lab/Geophysics Directorate  
 Hanscom AFB, MA 01731

James F. Lewkowicz, PL/LW  
Phillips Lab/Geophysics Directorate  
Hanscom AFB, MA 01731

Phillips Laboratory (PL/XO)  
Hanscom AFB, MA 01731

Dr. James Hannon  
Lawrence Livermore National Laboratory  
P.O. Box 808  
Livermore, CA 94550 (2 copies)

Office of the Secretary of Defense  
DDR&E  
Washington, DC 20330

Eric Chael  
Division 9241  
Sandia Laboratory  
Albuquerque, NM 87185

Dr. William Leith  
U.S. Geological Survey  
Mail Stop 928  
Reston, VA 22092

Dr. Robert Masse  
Box 25046, Mail Stop 967  
Denver Federal Center  
Denver, CO 80225

Dr. Robert Reinke  
WL/NTESG  
Kirtland AFB, NM 87117-6008

## CDRL MAILING LIST-NM

ORGANIZATION	NAME	NO. COPIES
NON-GOVERNMENT CONTRACTORS		
CALTECH	AHRENS	1
SAIC, SAN DIEGO	BACHE, SERENO	2
CANADA, GEOL SURVEY	BASHAM	1
ENSCO, SPRINGFIELD, VA	BAUMGARDT/DER	1
UCSD	BERGER	1
VPI	BOLLINGER	1
SAIC, ROSSLYN	BRATT, CARTER, LIBRARIAN	3
TELEDYNE, GARLAND, TX	BROWNE	1
WOODWARD-CLYDE	BURDICK	1
SHI	CHEFFY	1
U. TORONTO	CHUN	1
UCLA	DAVIS	1
SAN DIEGO STATE U.	DAY	1
SWEDEN, NAT. DEF. RES. INST.	EVA JOHANNISSON	1
MRC, SANTA BARBARA	FISK	1
UCSC	FLATTE	1
PSR	FRITZEL	1
GERMANY, FUHRU	HARJES	1
CALTECH	HELMBERGER	1
SMUGEOPHYS. LAB	HERRIN, STUMP	1
CORNELL	ISACKS, BARAZANGI	1
UCB	JOHNSON, MCEVILLY	1
ENSCO, MELBOURNE, FL	KEMERAT	1
ANU	KENNETT	1
LINCOLN LAB	LACOSS	1
U. ILL	LAMB	1
PENN STATE U.	LANGSTON	1
UCSC	LAY, SCHWARTZ	1
LDGO	LENER-LAW/RICHARDS	1
GERMANY, FED INST	MANFRED HENGER	1
AWFE	MARSHALL	1
NER	MARTIN	1
FRANCE, RADIOMANA	MASSINON, MECHELER	2
SMU/PHYSICS DEPT	MCCARTOR, GRAY	1
S-CUBED, LA JOLLA	MCLAUGHLIN	1
UCSD	MINSTER, ORCUTT, GIVEN	2
ST LOUIS U	MITCHELL, HERRMANN	1
S-CUBED, RESTON	MURPHY	2
RADIX	PULLI	1
NORWAY, NTNF	RINGDAL	2
TELEDYNE, ALEXANDRIA, VA	RIVERS	2
TASC	SAILOR	1

## CDRL MAILING LIST-NM

ORGANIZATION	NAME	NO. COPIES
USC	SAMMIS, AKI	1
IRIS	SIMPSON	2
U. WASHINGTON	SMITH	1
U. WISCONSIN	THURBER, MEYER	1
MIT	TOKSOZ/DAINTY	1
U. AZ	WALLACE	1
MRC, NEWINGTON, VA	WORTMAN	1
US GOVERNMENT AGENCIES		
ACDA	LIEBERMAN	1
AOSRNP	JERRY PERRIZO	1
AFTAC, CSS, ROSSLYN, VA	BLANDFORD	1
AFTAC/CA	STINFO	1
AFTAC/TT	PILOTTE	1
CIA/ACIS	KATIE POLEY	1
CIA/OSWR	TURNBULL	1
DARPA	ALEWINE, RYALL, KERR	7
DARPA/FMO	LIBRARIAN	1
DIA	GLOVER	1
DNA/SPSS	SHORE	1
DOE	KOONTZ	1
DTIC	INFO CTR	2
GL/LWH	CIPAR	1
GL/LWH	LEWKOWICZ	1
GL/XO	XO	1
LLNL	HANNON	2
OSD	DORE	1
SANDIA	CHAEI	1
USGS	LEITH	1
USGS	MASSE	1
WL/NTESG	RENKE	1
TOTAL NUMBER OF REPORTS		88