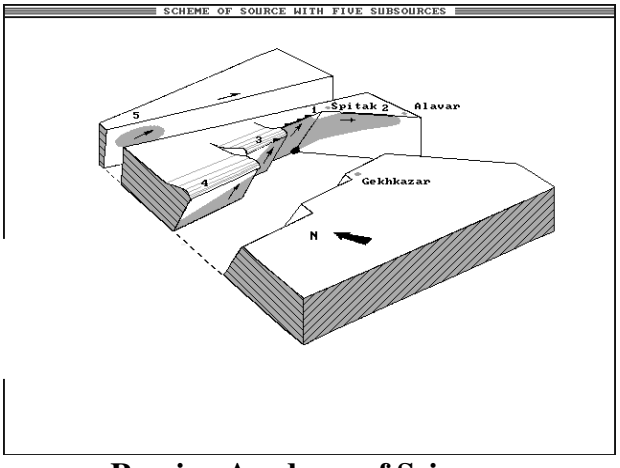
SPITAK EARTHQUAKE

DECEMBER 7, 1988

CD-ROM User's Manual



Russian Academy of Sciences
National Geophysical Committee
Geophysical Center

and
National Oceanic and
Atmospheric Administration
National Geophysical Data Center

in collaboration with
Joint Institute of the Physics of the Earth
Institute of Geophysics and
Center of Geophysical Computer Data Study

SPITAK EARTHQUAKE-DECEMBER 7, 1988
CD-ROM User's Manual

by

G. Sobolev
National Geophysical Committee, RAS,
Molodezhnaya, 3, 117296, Moscow, Russia

Yu. Tyupkin, I. Frolov, N. Sergeeva,
Geophysical Center, RAS,
Molodezhnaya, 3, 117296, Moscow, Russia

S. Arefev, A. Govorov, E. Rogozhin, R. Tatevasyan, M. Zhizhin
Institute of the Physics of the Earth, RAS,
B. Bruzinskaya, 10, 123810, Moscow, Russia

Yu. Schukin
Research Institute for Geophysics, Moscow, Russia

P. Lockridge, R.E. Habermann, L. Whiteside,
A.M. Hittelman, H. Meyers
National Geophysical Data Center, NOAA
Boulder, CO, USA

A. Malitzky
Seismological Division, Institute for Petroleum Research and Geophysics,
P.O. Box 2286, Holon 58122, Israel

September 1994

UNITED STATES DEPARTMENT OF COMMERCE
Ronald H. Brown, Secretary

National Oceanic and Atmospheric Administration
D. James Baker, Administrator

National Geophysical Data Center
Michael A. Chinnery , Director

DISCLAIMER

While every effort has been made to ensure that these data are accurate and reliable within the limits of the current state of the art, NOAA cannot assume liability for any damages caused by any inaccuracies in the data or as a result of the failure of the data to function on a particular system. NOAA makes no warranty, expressed or implied, nor does the fact of distribution constitute such a warranty.

The user must be cautious when using these data and computer programs. These programs are for display and information purposes only. As in many complex scientific endeavors, errors can be expected.

TRADEMARK ACKNOWLEDGMENTS

In this documentation, trademarked commercial products and companies are named. Mention of a commercial company or product does not imply endorsement by NOAA or the Department of Commerce. Use for publicity or advertising purposes of information from this publication concerning proprietary products or the tests of such products is not authorized.

Throughout the publication, rather than put a trademark symbol in every occurrence of a trademarked name, we state that we are using the names only in an editorial fashion with no intention of infringement of the trademark.

CONTENTS

INTRODUCTION **5**

PURPOSE OF THIS COMPILATION 5

CHAPTER 1: PROGRAM BACKGROUND **7**

CHAPTER 2: SOFTWARE **9**

A GENERAL LOOK AT THE ACCESS SOFTWARE 9
ACCESSING DATA WITH SPITAK DATA BASE SOFTWARE (SDBS) 10
Installation 11
ACCESSING DATA WITH GEOVU SOFTWARE 12
Hardware and Software Requirements 12
GeoVu Loading Instructions 12
Overview of GeoVu Access Software 13
General Notes 14
Hints on Using GeoVu to Display Spitak Earthquake Data 14
A Sample Session 14
Future Software and Data Release Plans 16

CHAPTER 3: TECHNICAL SPECIFICATIONS **17**

THE COMPACT DISC FORMAT 17
CARE AND HANDLING OF CD-ROM 17
DIRECTORY STRUCTURE OF THE CD-ROM 17

CHAPTER 4: DATA DESCRIPTION **18**

THE DATA BASE CONTENTS 18
General Description. 18
Geology and Geophysics. *19*
The Main Shock 20
Aftershocks 20
Impact 20
Elements of Prediction 21
Wave Forms 21
OUTLINE OF DATABASE 22

CHAPTER 5: ACKNOWLEDGMENTS **30**

PROGRAM SUPPORT 30
STAFF CREDITS 30
ACKNOWLEDGMENTS 30

INTRODUCTION

PURPOSE OF THIS COMPILATION

The purpose of this compilation is to provide seismologists around the world with a complete set of data for the devastating earthquake that occurred in Armenia on December 7, 1988. This set consists of textural and graphical information about the earthquake, a "DOS" menu for accessing the data, the GeoVu software package also for accessing the data, and this manual which discusses the data and explains how to use GeoVu to display and obtain useful information from these data.

The 1988 Armenian earthquake is unique both in catastrophic effects and in study coverage. Research groups from the former U.S.S.R., U.S.A., France, and Japan studied the earthquake area. The International Decade of Natural Disaster Reduction (IDNDR) Commission of the IASPEI, has undertaken creation of the "Spitak Earthquake of 1988" database to make the enormous amount of data obtained by these research groups available to the global scientific community.

This project involves a number of diverse geophysical and computer science challenges. The resulting data base contains practically all material relevant to the Spitak earthquake and its after effects, and also the geological-geophysical information collected during the years prior to the event important for understanding the event. So far as we know, it is the first data base containing such a complete integrated description of a catastrophic earthquake.

The compact disc contains approximately 180 megabytes. The majority of the data consists of descriptive text files and maps, charts, photos, and other graphic images in "pcx" files.

The National Oceanic and Atmospheric Administration (NOAA) appreciates the value of integrated data management, and has assembled data for this compact disc in order to simplify the work of scientists performing regional and global geophysical studies. The compact disc medium was selected because it is capable of storing a large quantity of data, while providing easy and cost-effective retrieval in a desktop environment. The primary application for this disc is research into the many facets of a devastating earthquake.

We at NOAA view this as an "evolving" product. As such, your input on future improvements is very much needed. What other access capabilities should we develop? Are we going in the right direction?

Contacts: National Geophysical Data Center
NOAA, E/GC1
325 Broadway
Boulder, Colorado 80303-3328
Fax: 303-497-6513

End user support: Allen M. Hittelman
Phone: 303-497-6591
Internet: ahittelman@ngdc.noaa.gov

Data products: Patricia Lockridge
Phone: 303-497-6221
Internet: plockridge@ngdc.noaa.gov

Chapter 1: PROGRAM BACKGROUND

A recent seismic catastrophe, the Spitak (Armenia) earthquake of December 7, 1988, killed tens of thousands of people. The purpose of this compilation is to learn from this tragic event so that the effects of such events may be mitigated in the future.

A vast amount of information is needed in order to develop strategies for mitigating impacts of catastrophic earthquakes. This includes aspects of the natural environment, the performance of man-made structures, and the earthquake itself. Recent advances in digital data storage have made it possible to collect these data onto a single compact disk, greatly simplifying the process of data access and distribution. The authors have endeavored to collect a complete set of observational data on the Spitak earthquake of 1988. This is the first attempt to build up a complete collection for a comprehensive description of a disastrous earthquake.

The major challenge facing the seismologists is to learn to predict future catastrophes. The seismologists gain information about future events from the past earthquakes, and the vast worldwide experience of earthquake observations can be now concentrated in the evaluation of seismic risk for every individual territory. Moreover, the Spitak earthquake was the incentive that urged the international seismological community to join efforts in solution of problems of global control over current geotectonic processes. For this purpose, a standardized network of seismic stations is being established, and a set of techniques is elaborated to achieve earthquake prediction. The scientists from the former Soviet Union were among those who essentially contributed to the solution of this problem. Their methods of long-term forecasts permit the determination of the place of the future strong earthquake, thus allowing preparatory measures to be taken in the region and organization of detailed prognostic research. These potentialities, however, are seldom applied in actual practice.

The situation is further aggravated by the fact that all earthquakes have common features and yet every one is different owing to its own peculiar tectonic environment. Though scores of effects are known to precede earthquakes yet each event has its own set of forerunners most of which are very weakly manifested. Therefore, the basic strategy of prediction is to derive a reliable conclusion from a multitude of indications every one of which individually is insufficiently reliable. Concurrently, however, we should strive towards the most detailed study of structure of seismically active regions to understand the specific features of formation of sources in each region and, consequently, to select an optimal system of prognostic observations.

The program worked out by the former Soviet Union after the Spitak earthquake was made to provide for control of geophysical, geochemical, deformational and hydrogeological processes and for development of a special network of observations in all seismic regions. It is planned to establish such a network in the next few years by incorporating the most efficient scientific experience in the world and in this country and by using the most advanced technologies.

The Spitak earthquake has emphasized that one of the most important problems is the state of anti seismic construction. Strong earthquakes occur in places where they happened in the historical past, and so the approximate force of the future seismic shock can be predicted. Seismic loads can be calculated and the buildings erected to withstand the earthquake. Still the risk of damage remains, because it is not only necessary to build strictly following the specifications but it is also essential to use the buildings keeping to the rules of usage and under current geophysical control. Solution of these problems depends on the progress in science and on the general state of culture and welfare in the wide meaning of these terms, which ranges from the quality of research, of drawing projects and buildings, of the usage of dwellings and industrial constructions to the capacity of the whole society and of individuals to bear responsibility for adopted decisions.

The catastrophic earthquake in Armenia has raised a heated debate. Scientists and journalists, specialists of various professions, debate whether the earthquake could have been predicted beforehand, and not only its locality but the time of occurrence as well, to warn the population.

What requirements should be fulfilled by anti seismic construction in seismically prone zones? How can the medical and psychological assistance be organized to help the victims of an earthquake?

What should be the system of reaction to natural disasters, such as the earthquake in Armenia?

It is our task to collect in this database the information about the Spitak earthquake and to make it useful for researchers working to find solutions to these problems.

N. Laverov
Vice-President,
Russian Academy of Sciences

Chapter 2: SOFTWARE

A GENERAL LOOK AT THE ACCESS SOFTWARE

Two types of software, SDBS (Spitak Data Base Software) and GeoVu, provide access to the database. SDBS is the software especially developed to work the database "Spitak Earthquake of 1988." As with many specialized software packages, SDBS provides quick and logically reasonable access to information.

NOAA's National Geophysical Data Center has produced numerous diverse collections of data on CD-ROMs and has developed general tools for accessing such collections. This collection (the Spitak Earthquake CD-ROM) is similar to those on several CD-ROMs of natural hazards photographs produced at NGDC, so it was decided to experiment with access to this CD using GeoVu, a general data browser developed at NGDC.

Many of the differences between the GeoVu and SDBS implementations of this data collection reflect the fact that the data and the SDBS were developed hand-in-hand and that GeoVu was developed independently. The purpose of this experiment was to compare access to an existing data collection with specialized software with access by a generic tool which can be used with numerous data collections. Such comparisons are rare, yet they yield important information on the trade-off between expensive development and maintenance efforts and data access.

GeoVu provides access to all of the data files included on the CD as well as to the PCX images. It also includes a Slide Show feature which allows quick browsing of sections of the CD. Guidance in data selection is provided by a menu system similar to that used by SDBS. For the earthquake catalogs (point data) GeoVu offers a "View Histogram" feature. The histogram plots show the occurrences counted for values of a variable. This feature is for browsing pre-computed histogram information and does no data processing or computations.

The menu structures differ in several ways, reflecting differences in views of the data collection and flexibility which is built in to the GeoVu menu system. GeoVu is presently available for Microsoft Windows and will be available for some UNIX platforms and Macintosh's by the end of 1995. The most recent release of GeoVu and documentation are available via ftp in the Access_Tools directory at ftp.ngdc.noaa.gov, or via Mosaic at www.ngdc.noaa.gov.

ACCESSING DATA WITH SPITAK DATA BASE SOFTWARE (SDBS)

The user has access to information through the menu system, which allows:

- use of the next level menu for the same operations provided by the previous menu level;

- use of the Ground Level Menu (GLM) to provide direct access to: textual information in ASCII files, information ASCII tables with a special headline for displaying the titles to table columns, and graphic information presented in PCX format. In the latter case, the user can be supplied with an additional sub-menu giving access to several graphic and textual files

- linkage of external executive programs (EEP) that provide access to data bases through their own menu system. "TEXT" and "DATA" buttons allow display of text, searches with a given set of symbols, and text output to a printer or a file.

The set of programs which are available to SDBS provide the displays of the maps on the screen. The graphic information is displayed by means of pull-down menus. Moreover, these programs have access to the digital data bases. Some of these programs allow one to obtain not only the values of any of the fields in a given grid cell but also plot along a linear profile. In the latter case, it is possible to draw profile plots of two different fields simultaneously. The selected information can be exported into a file indicated by the user.

Two types of software are used in the mode of EEP for access to Wave Form Databases. Access to the Global Digital Seismological Network Database is achieved by the WF software. This software has the ability to select a digital seismogram from the database, display it on the screen, mark wave arrivals, rotate the record, particle motion diagram, compute the complex transfer function of the digital recording system, execute polarization analysis, spectral analysis, filtration, and de convolution of the seismic records. WF software can be used independently of SDBS. The seismic data used by WF software can be obtained also from a search of the NEIS - Event Data CD-ROM using the package SONIC.

Access to the database "Strong Motion" and "Digital Accelerogram" is made through SMDB software, which permits:
selection of the requisite record from the data base;

- display of information about the event to which the selected record pertains;
- display of information about the recording instruments and their location;
- display of environmental setting;
- display of the graphic image of the record;
- selection of a part of the record;
- export of the selected information into a user selected file

In addition, because the number of the records in the databases can be large, the SMDB software has the capability of creating a virtual database from records satisfying the given conditions. These conditions are: the time interval, the geographical position of the recording stations, or their codes

This allows the user to operate only with records of interest. This arrangement considerably shortens the time and simplifies the process of access to information.

Installation

To install the software for Database "SPITAK EARTHQUAKE, 1988" one has to start INSTALL.BAT from the Directory INSTAL on CD. Directories C:\SPBATCH and C:\SPITAKWF will be created. One can start now C:\SPBATCH\SPITAK.BAT to input the Database "SPITAK EARTHQUAKE, 1988 "

560Kb of free memory is necessary for software. You must have 800 K free space on the disk C. You must create the directories described during installation for output data from Strong Motion records Database and Accelerogram Records Database. Please take into account that WF software (Access to the Global Digital Seismological Network Database) requires a math coprocessor.

Some types of mouse drivers are not acceptable. Please change @ST.EXE by @RT.EXE or by @RT.EXE/1 in batch file SPITAK.BAT if the machine locks up at the stage of transmission from a graphic mode to a text mode. Please switch off or change mouse driver if these modifications don't solve the problem.

Hardware and Software Requirements

The access software provided with this package will operate on any IBM-PC/AT or compatible personal computer, with MS Windows (3.1) and a compatible CD-ROM reader. The software is not designed to operate on other types of computers (e.g., Macintosh); however, support for other platforms is expected in the future.

Three megabytes of hard disk space are required to load and execute the software. A large capacity hard disk is needed if large files are to be copied from the CD, or if many screen images are to be saved. We recommend using a computer with a minimum of eight megabytes of RAM. A math coprocessor should significantly speed up the application.

GeoVu Loading Instructions

The GeoVu software is provided on the CD-ROM in L:\GEOVU\SETUP

1. Insert the CD-ROM into the appropriate drive. (Make sure the reader is turned on).

2. With Windows operating, run the program SETUP by choosing the Program Manager File menu to select RUN. If L: is the drive used, type L:\GEOVU\SETUP in response to the Run dialog.

3. Follow the installation instructions on the screen. The contents of the GeoVu directory will be copied to your hard drive in the directory of your choice. The default installation default will create a directory, "GeoVu," in the same drive as your Windows directory (e.g., C:\GEOVU). The install will also create a file, FREEFORM.INI, in your Windows directory, and create a GeoVu Program Manager Group and icon.

4. You can set the CD-ROM drive letter while GeoVu is running. However, to have it appear as a default you need to edit the distribution copy of CDMENU.LST (found in your GeoVu directory) so the letter matches your configuration. Editing instructions are found within this ASCII file.

Overview of GeoVu Access Software

There are several ways to run GeoVu:

1. To start GeoVu as a Windows desktop application, double-click on the GeoVu icon.

2. Remember that GeoVu help is available through either a HELP key or F1.

Pull-down menus are a familiar part of any Windows application. They appear at the top of the application window, and each one displays a family of commands when you click on it. The GeoVu menus are File, Edit, Search, Documents, GeoRef, Windows, Utilities, and Help.

There are three major components of GeoVu: (1) The data description layer, known as FREEFORM, (2) The data navigation layer, known as the Menu Guide, and (3) The data browse and retrieval layer, referenced as GeoVu.

When a user requests data, GeoVu searches for a format description using the FREEFORM layer (descriptions exist within the data compilation in the form of format files, .FMT). For data not previously defined, the user is prompted for format information.

Data are often described in CD-ROMs in obscure ways, leaving users to guess the exact meaning of a cryptic file name. GeoVu's Menu Guide removes this obstacle by providing understandable navigation throughout the data compilation. The actual menu guide is written in an ASCII text, which GeoVu translates into screen dialogues with companion help panels. Using the Menu Guide, data producers are provided with a mechanism of integrating data documentation with the data itself; data users are rewarded with screen-sensitive help and information.

The browse and retrieval capabilities of GeoVu were designed to provide users with a quick-look and data extraction capabilities. GeoVu was not designed to provide GIS-level or sophisticated analysis level features, since numerous commercial products serve this function well. Rather, GeoVu was conceived to provide a link between data compilations and the researcher's analytic application of choice. The following descriptions highlight GeoVu's major capabilities:

1. Display grids and images—with pan, zoom, profile, value look-up, color manipulation and histogram support

2. Display tabular data sets—with two-dimensional plots of any combination of parameters

3. Display correlative documentation—in the form of scrollable text boxes

4. Extract data—in multi-platform representations, with choices of data content and structure.

General Notes

A "**GeoVu User's Guide**" exists in the form of a PostScript file, GVHELP.PS. You may wish to print out this file.

Sometimes users open too many files, resulting in unfriendly computer memory messages. To help manage this situation, a STATUS display window is always available while running GeoVu. This helps you keep track of your open data and search definitions. The WINDOWS menu also helps by providing a list of all top-level display windows.

A double-click within an image display window will present image coordinates, data values, and class names.

To quit the application, click the FILE menu item Quit GeoVu or use the close box on the GeoVu window.

Hints on Using GeoVu to Display Spitak Earthquake Data

The data are accessible through a menu system that allows the user to:

- select a specific data set
- browse data set documentation
- browse tabular data as histograms
- define the desired output (screen display, data to disk or floppy)
- view the selected data (using standard or user defined palettes)

A Sample Session

1. The initial screen to appear will be a STATUS dialog screen:

Open Data Sets:
None
Searches Created:
None

2. Select FILE from the menu bar.

3. Choose "Set Data Source".

4. Select "SPITAK EARTHQUAKE Dec. 7, 1988"
   Note: if you don't see this title on the list, it will be necessary to edit the GeoVu Data Source List. This can be done from within GeoVu by using the "Edit" function's "Data Source List" option.

5. Change the CD-ROM drive letter, if necessary, and click OK. This will bring up an INTRODUCTION dialog screen.

6. Select "Open Data". The user will now be presented with the Spitak Earthquake CD dialog screen. (Note: If the "OK" was selected, you close the dialog.)

FACTS	provides description and format information
PREV	returns user to the INTRODUCTION screen
NEXT	allows user to select a submenu
CANCEL	allows user to return to the STATUS screen
OK	allows user to select an item to view

7. To display data: Select "OK". The processing information screen comes up. The message "Please wait" and a percentage of the processing that has been completed is displayed. When the image has been processed, it displays on the screen

8. When the image is displayed, one may select "FACTS," "ZOOMIN," etc. to further investigate the image. "HIST" gives a histogram of the colors in the image and is not significant for these PCX images. "PROFILE" also is not activated for these PCX images. There is no "GEOREF OVERLAY" available for these images. The palette is fixed, so the COLOR option also is not applicable to this image type.

The previous sample session focused only on searches that produce a graphic display. However, when you create a search (object) you have other options, such as: (1)

searches can generate a disk file, and (2) the search criteria itself can be saved. Use the search name edit box to give each search a unique name. This is useful, especially if you wish to revise existing search criteria. Please note that GeoVu has standard file extensions used when writing and reading files.

Future Software and Data Release Plans

There are several GeoVu software releases planned during 1994–1995:

MS-Windows Release—included in this product, operates in a Microsoft Windows environment.

Future Window Releases—will expand platform compatibility to include UNIX (Sun with "Open Look") and Macintosh.

Updates to GeoVu will be available free over Internet or for a diskette copying fee. Please send all inquiries about updates to Allen Hittelman via the address provided on page 2.

Chapter 3: TECHNICAL SPECIFICATIONS

THE COMPACT DISC FORMAT

The data on the CD-ROM are in the International Organization for Standardization (ISO) 9660 format. Mastering of the CD-ROM disc and replication of the copies were done by Disc Manufacturing, Inc., Anaheim, California, under contract to NGDC.

CARE AND HANDLING OF CD-ROM

Handle the CD-ROM carefully to avoid damage. Dust, scratches, ink, paint, and fingerprints may obscure some of the data. With careful handling, one can expect at least a 10-year lifetime for the data disc.

DIRECTORY STRUCTURE OF THE CD-ROM

The compact disc contains approximately 180 megabytes of data. The majority of the data consists of graphical representations of data relationships.

GeoVu has standard file extensions used when writing and reading files and these may also appear on CD-ROM products:

.BIN	binary data files
.FMT	format descriptions
.HDR	header files documenting grid data
.MEN	menu file
.TXT	documentation in ASCII

CHAPTER 4: DATA DESCRIPTION

The database has the following subdivisions: Geology, Geophysics, Main Shock, Aftershocks, Impact (epicentral area, towns, buildings), Elements of Prediction, and Seismic Wave Forms. Information is represented by a set of computer maps with digital data and text used as a basis for the maps. The data management system makes the data easily available to the user. This version of the data base is designed for IBM PC/AT compatible computers, and includes about 165 Mb of information and data. The information included in the database comes in several forms, some familiar (local and teleseismic seismic waveforms of the Main Shock and of related events), and some unusual.

A large part of the information is presented as images in the PCX format. These images were created at the World Data Center B (Geophysical Center) in Moscow and include a variety of maps, cross-sections, and photographs, as well as x-y plots of data related to the earthquake and the region where it occurred. The data depicted in these images is, for the most part, not included in the database.

The primary benefit of this approach is that it significantly standardizes the information to be presented and, therefore, simplifies the process of presentation. Unfortunately much of the information presented as images is not accessible as "data" in the typical usage of the word. The information on the disc that is available as data is principally wave forms, the seismicity catalogs, and some of girded geophysical parameters. We identify these data sets below with an asterisk.

THE DATA BASE CONTENTS

The database "Spitak Earthquake of 1988" has the following parts:

General Description.

Brief historic, economic, and geographic descriptions of Armenia with a review of the seismic history of the region, including:

- Catalog of regional historic earthquakes*
- Isoseismal maps of the sixteen best studied earthquakes
- Catalog of strong earthquakes*
- Instrumental catalog of earthquakes*
- The seismic zoning map of the U.S.S.R. showing the territory of the Caucasus.

Geology and Geophysics..

Geologic, tectonic and geophysical fields of the region, including geologic data collected in the epicentral area after the earthquake.

- The geologic-tectonic characteristics of the region include:
- Map of major faults of the Caucasus
- Map of lineaments and fractures of Transcaucasian Transversal Rise
- Map of active faults
- Map of largest active faults of the Near East and Transcaucasia
- The geological-geophysical characteristics of the region include:
- Amplitudes of neotectonic movements*
- Gradient of velocity of post-sarmatian vertical tectonic movements*
- Distribution of geological heterogeneity*
- Distribution of Mesozoic-Cenozoic faults*
- Density of faults of different ranks*
- Mohorovicic discontinuity relief*
- Surface of consolidated basement*
- Bouguer anomalies of gravity field
- Isostatic gravity anomalies*
- Magnetic field anomalies*
- Heat flow anomalies*
- Temporal anomalies of first arrivals of crustal waves*
- Variations of upper mantle horizontal velocity*
- Surface relief*

These fields are included in a single digital database with the values of the indicated parameters averaged over 5'x5" grids. The user can display a map of a certain parameter and also obtain information on the value of any parameter at a given point or along a linear profile. These fields are also available as simple binary data files which can be imported into other visualization or mapping software systems.

The description of the epicentral zone includes:

- Structural geologic map
- Map of earthquake ruptures (on geologic basis)
- Structure of the zone of seismic ruptures in trenches
- Morphology of seismic ruptures
- Implicated deformations of Quaternary terraces of the Pambak River

and also cross-sections of the following fields along the section of the Epicentral Area:

- Seismic section
- Anomalies of magnetic field
- Bouguer anomalies
- Topography
- Heat flow

The Main Shock

- General information about the event
- Fault plan solution
- An example of near field records
- An example of teleseismic records
- Isoseismal map of the main shock
- The model

Aftershocks.

- Catalog of aftershocks*

and

-Illustrations of the aftershock process, namely:

- Cross sections of depth through aftershocks swarm
- Fault plane solutions
- Variations of seismic parameters
- Radiation patterns

Impact

The section includes information about geological or geophysical parameters which influence (or may influence) the effects of the earthquake, and about the effects of the Spitak earthquake themselves. This part is arranged in such a way as to enable the user to have access to the information on different spatial scales ranging from the regional level to specific information on three cities: Spitak, Kirovakan, Leninakan.

This part also includes statistics of damage to multistory residential buildings for 23 cities in Armenia, photographs and brief descriptions of landslides, and, finally, data on certain engineering aspects of the earthquake. This later information contains data on response spectra characteristics, data on angles of emergence of seismic rays, and information about the behavior during the earthquake of the major types of buildings (stone masonry bearing-wall buildings, pre-cast concrete-frame buildings, pre-cast large panel buildings, lift-slab buildings, and industrial facilities.).

Elements of Prediction

Before the Spitak earthquake in the Caucasus, different methods were applied to reveal precursors on a wide network of seismic stations and from many years of study of seismic precursors. Other types of precursors were also studied, including observations of ground water levels, and geomagnetism as well as experimental deformation studies.

Unfortunately, the social and political situation in Armenia in 1988 obstructed the systematic collection and processing of data on earthquake prediction. Even earthquake catalogs were published with a delay of one year. Because of this situation, no prompt observations of variations of prediction parameters were carried out. Therefore the occurrence of anomalies or precursors were not properly considered.

This part of the database contains a certain amount of information on seismological, hydrodynamics, electromagnetic and biological precursors and of the deformation process before the Spitak earthquake.

Wave Forms

- Three independent databases of seismic wave forms are included:
- The database of seismograms of the global seismic network;
- The database of seismograms of a telemetric network of temporary stations;
- The database of digital records of strong motion.

OUTLINE OF DATABASE

Following is an outline of the GeoVu menu for the Spitak CD ROM. Please note that this menu differs from the DOS menu for the CD ROM. Also please note the letters in parenthesis following each menu item.
"f" indicates that there are "facts" available for that menu item.
"g" indicates that there is a "graphic" for that menu item.
"d" indicates that there is "data" available for that menu item.

I. Background information on Armenia (f)
- A. Geography of Armenia (f)
  - 1. Geographical location of Armenia #\SPITAKDB\COLGEOGR\SC00101C.PCX (f,g)
  - 2. Map of northern Armenia #\SPITAKDB\COLGEOGR\SC00101E.PCX (f,g)
- B. Topography of Spitak area (f)
  - 1. Topography map of Spitak area #\SPITAKDB\COLTOPO\SC00101C.PCX (f,g)
  - 2. Spitak topography map legend#\SPITAKDB\COLTOPO\SC00101D.PCX (f,g)
- C. Map of average rainfall for Armenia #\SPITAKDB\COLRAINF\SC00101C.PCX (f,g)
- D. Historical seismic data and maps (f)
  - 1. Regional historical earthquake catalog #\SPITAKDB\COLRCAT\regional.bin (f,d)
  - 2. Isoseismal maps (f)
    - a. 1827 October (Tsakhkadzor) #\SPITAKDB\COLIMAP\SC00101C.PCX (f,g)
    - b. 1899 December 31 (Akhalkalaki) (f)
      - 1. 1899 December 31 Regional area #\SPITAKDB\COLIMAP\SC00102C.PCX (f,g)
      - 2. 1899 December 31 Epicentral area #\SPITAKDB\COLIMAP\SC00102D.PCX (f,g)
    - c. 1903 July 09 #\SPITAKDB\COLIMAP\SC00103C.PCX (f,g)
    - d. 1906 October 20 #\SPITAKDB\COLIMAP\SC00104C.PCX (f,g)
    - e. 1912 October 12 (Tskhara-Tskaro) (f)
      - 1. 1912 October 12 Regional area #\SPITAKDB\COLIMAP\SC00105C.PCX (f,g)
      - 2. 1912 October 12 Epicentral area #\SPITAKDB\COLIMAP\SC00105D.PCX (f,g)
    - f. 1914 December 3 #\SPITAKDB\COLIMAP\SC00106C.PCX (f,g)
    - g. 1915 April 1 #\SPITAKDB\COLIMAP\SC00107C.PCX (f,g)
    - h. 1916 November 14 #\SPITAKDB\COLIMAP\SC00108C.PCX (f,g)
    - i. 1926 October 22 (Leninakan) #\SPITAKDB\COLIMAP\SC00109C.PCX (f,g)
    - j. 1935 January 25 (Akhuryan) #\SPITAKDB\COLIMAP\SC00110C.PCX (f,g)
    - k. 1937 September 14 #\SPITAKDB\COLIMAP\SC00111C.PCX (f,g)
    - l. 1948 May 23 #\SPITAKDB\COLIMAP\SC00112C.PCX (f,g)
    - m. 1958 May 31 #\SPITAKDB\COLIMAP\SC00113C.PCX (f,g)
    - n. 1959 December 8 (Madatapa) (f)
      - 1. 1959 December 8 Regional area #\SPITAKDB\COLIMAP\SC00114C.PCX (f,g)
      - 2. 1959 December 8 Epicentral area #\SPITAKDB\COLIMAP\SC00114D.PCX (f,g)
    - o. 1961 December 3 (Gukasyan) #\SPITAKDB\COLIMAP\SC00115C.PCX (f,g)
    - p. 1967 January 30 (Spitak) #\SPITAKDB\COLIMAP\SC00116C.PCX (f,g)
  - 3. Strong earthquakes catalog #\SPITAKDB\COLCAUC\historic.bin
  - 4. Instrumental earthquakes catalog and maps (f)
    - a. Instrumental earthquakes catalog #\SPITAKDB\COLINSTC\instcat.bin (f,d)
    - b. Distribution of earthquakes, 1961-1962 map #\SPITAKDB\COLINSTC\SC00101C.PCX (f,g)
    - c. Map of epicentral zone x-section #\SPITAKDB\COLINSTC\SC00101D.PCX (f,g)
    - d. 3-D View of Epicentral zone #\SPITAKDB\COLINSTC\SC00101E.PCX (f,g)
- E. Seismic zones in Armenia (f)
  - 1. Seismic zones in Armenia #\SPITAKDB\COLSZON\SC00101C.PCX
  - 2. Legend #\SPITAKDB\COLSZON\SC00101D.PCX

II. Geology and geophysics (f)
- A. Regional Tectonics (f)
  - 1. Map of major faults of the Caucasus (f)
    - a. Map of major faults of the Caucasus #\SPITAKDB\COLFRACT\SC00101C.PCX (f,g)
    - b. Legend #\SPITAKDB\COLFRACT\SC00101D.PCX (f,g)

2. Lineaments map-Transcaucasian trans. rise #\SPITAKDB\COLLINEA\SC00101C.PCX (f,g)
3. Active faults map-Lesser Caucasus (f)
    a. Map of active faults #\SPITAKDB\COLACTIV\SC00101C.PCX (f,g)
    b. Legend #\SPITAKDB\COLACTIV\SC00101D.PCX (f,g)
4. Largest faults map-Transcaucasia (f)
    a. Largest active faults map #\SPITAKDB\COLTECTO\SC00101C.PCX (f,g)
    b. Legend #\SPITAKDB\COLTECTO\SC00101D.PCX (f,g)

B. Regional Geology (f)
1. Amplitudes of Neotectonic movements graphic #\PCT\GEOPHYSI\G0012.PCX (f,g)
2. Gradient of velocity of Post-Sarmatian movements graphic #\PCT\GEOPHYSI\G0007.PCX (f,g)
3. Distribution of geological heterogeneity graphic #\PCT\GEOPHYSI\G0005.PCX (f,g)
4. Distribution of Mesozoic-Cenozoic faults graphic #\PCT\GEOPHYSI\G0015.PCX (f,g)
5. Density of faults of different ranks graphic #\PCT\GEOPHYSI\G0002.PCX (f,g)

C. Regional Geophysics
1. Mohorovicic discontinuities relief #\PCT\GEOPHYSI\G0011.PCX (f,g)
2. Surface of consolidated basement #\PCT\GEOPHYSI\G0009.PCX (f,g)
3. Bouguer anomalies of gravity field #\PCT\GEOPHYSI\G0001.PCX (f,g)
4. Isostatic gravity anomalies #\PCT\GEOPHYSI\G0006.PCX (f,g)
5. Anomalies of magnetic field #\PCT\GEOPHYSI\G0014.PCX (f,g)
6. Anomalies of heat flow #\PCT\GEOPHYSI\G0013.PCX (f,g)
7. Temporal anomalies of first crust waves #\PCT\GEOPHYSI\G0003.PCX (f,g)
8. Variation of upper mantle horiz. vel. #\PCT\GEOPHYSI\G0004.PCX (f,g)

D. Structural geology & ruptures in epicentral area (f)
1. Trace of rupture near Spitak (f)
    a. Map of trace on Landsat image #\SPITAKDB\COLEGEO\SC00102C.PCX (f,g)
    b. Map of surface rupture trace #\SPITAKDB\COLEGEO\SC00102E.PCX (f,g)

2. Structural geological map (f)
    a. Epicentral area structural geology map #\SPITAKDB\COLEGEO\SC00101C.PCX (f,g)
    b. Geological map cross section #\SPITAKDB\COLEGEO\SC00101D.PCX (f,g)
    c. Legend for geological map #\SPITAKDB\COLEGEO\SC00101E.PCX (f,g)

3. Map of seismic ruptures (f)
    a. Map of earthquake ruptures (geologic basis) (f)
        1. Ruptures map #\SPITAKDB\COLEGEO\SC00402C.PCX (f,g)
        2. Legend #\SPITAKDB\COLEGEO\SC00402D.PCX (f,g)
        3. References #$\SPITAKDB\COLEGEO\SC00402E.TXT (f,d)

    b. Map of seismic ruptures structure zone (f)
        1. Location of trenches #\SPITAKDB\COLEGEO\SC00403C.PCX (f,g)
        2. Legend #\SPITAKDB\COLEGEO\SC00403G.PCX (f,g)
        3. Trench 1 #\SPITAKDB\COLEGEO\SC00403D.PCX (f,g)
        4. Trench 2 #\SPITAKDB\COLEGEO\SC00403H.PCX (f,g)
        5. Trench 3 #\SPITAKDB\COLEGEO\SC00403E.PCX (f,g)
        6. Trench 4 #\SPITAKDB\COLEGEO\SC00403F.PCX (f,g)

    c. Morphology of seismic ruptures (f)
        1. Location of micropolygons #\SPITAKDB\COLEGEO\SC00404C.PCX (f,g)
        2. Micropolygon 1 #\SPITAKDB\COLEGEO\SC00404D.PCX (f,g)
        3. Micropolygon 2 #\SPITAKDB\COLEGEO\SC00404F.PCX (f,g)
        4. Micropolygon 3 #\SPITAKDB\COLEGEO\SC00404G.PCX (f,g)
        5. Micropolygon 4 #\SPITAKDB\COLEGEO\SC00404H.PCX (f,g)
        6. Legend #\SPITAKDB\COLEGEO\SC00404E.PCX (f,g)
        7. References #$\SPITAKDB\COLEGEO\SC00404I.TXT (f,d)

d. Map of Implicate deformations along Pambak River (f)
1.Deformation of Quaternary terraces map
#\SPITAKDB\COLEGEO\SC00405C.PCX (f,g)
2. Legend for implicate deformations map
#\SPITAKDB\COLEGEO\SC00405D.PCX (f,g)

E. Seismic section of epicentral area (f)
1. Location map of the section #\SPITAKDB\COLSSECT\SC00102C.PCX (f,g)
2. Seismic section map #\SPITAKDB\COLSSECT\SC00102D.PCX (f,g)
3. Magnetic field anomalies map #\SPITAKDB\COLSSECT\SC00102E.PCX (f,g)
4. Bouquer anomalies graphic #\SPITAKDB\COLSSECT\SC00102F.PCX (f,g)
5. Topography relief map #\SPITAKDB\COLSSECT\SC00102G.PCX (f,g)
6. Heat flow map #\SPITAKDB\COLSSECT\SC00102H.PCX (f,g)

F. Gridded geophysical parameters (f)
1. Amplitudes of neotectonic movements #\menu\db\geophys\neomove.bin (f,d)
2. Bouguer Gravity Anomalies #\menu\db\geophys\bouggrav.bin (f,d)
3. Depth of Consolidated Basement #\menu\db\geophys\conbase.bin (f,d)
4. Geological heterogeneity: Number of Geologic Structures in Cell #\menu\db\geophys\geohetro.bin (f,d)
5. Gradient modulus post-sarmatian vert tectonic vel #\menu\db\geophys\vertecmv.bin (f,d)
6. Heat Flow Anomalies #\menu\db\geophys\heatflow.bin (f,d)
7. Isostatic Gravity Anomalies #\menu\db\geophys\isograv.bin (f,d)
8. Magnetic Anomalies #\menu\db\geophys\magnetic.bin (f,d)
9. Number of Faults of different ages in a cell #\menu\db\geophys\numflt.bin (f,d)
10.P-Wave Travel Time Anomalies #\menu\db\geophys\pwavetim.bin (f,d)
11.Predominant Young's modulus of rocks #\menu\db\geophys\youngmod.bin (f,d)
12.Upper mantle horizontal velocity variations #\menu\db\geophys\upmanvel.bin (f,d)
13.Topographic Relief #\menu\db\geophys\topogrel.bin (f,d)
14.Mohorovicic discontinuity relief km #\menu\db\geophys\mohorel.bin (f,d)

III. Main shock (f)
A. Fault plane solution (f)
1. Log-likelihood function #\SPITAKDB\COLMSHOC\SC00103C.PCX (f,g)
2. First solution #\SPITAKDB\COLMSHOC\SC00103D.PCX (f,g)
B. Nearfield records (f)
1. Locations of earthquakes & seismic stations #\SPITAKDB\COLMSHOC\SC00104C.PCX (f,g)
2. W-E component #\SPITAKDB\COLMSHOC\SC00104D.PCX (f,g)
3. N-S component #\SPITAKDB\COLMSHOC\SC00104E.PCX (f,g)
4. Vertical component #\SPITAKDB\COLMSHOC\SC00104F.PCX (f,g)
C. Teleseismic records (f)
1. P-wave, Garm Seismic Station (f)
a. Garm Vertical P-wave #\SPITAKDB\COLMSHOC\SC00501C.PCX (f,g)
b. Garm Radial P-wave #\SPITAKDB\COLMSHOC\SC00501D.PCX (f,g)
2. P-wave, Obninsk Seismic Station (f)
a. Obninsk Vertical P-wave #\SPITAKDB\COLMSHOC\SC00503C.PCX (f,g)
b. Obninsk Radial P-wave #\SPITAKDB\COLMSHOC\SC00503D.PCX (f,g)
3. P-wave, Arti Seismic Station (f)
a. Arti Vertical P-wave #\SPITAKDB\COLMSHOC\SC00504C.PCX (f,g)
b. Arti Radial P-wave #\SPITAKDB\COLMSHOC\SC00504D.PCX (f,g)
D. Isoseismal map of main shock (f)
1. Main shock regional level #\SPITAKDB\COLMSHOC\SC00102C.PCX (f,g)
2. Main shock epicentral area #\SPITAKDB\COLMSHOC\SC00102D.PCX (f,g)
3. Seismic zones in Armenia #\SPITAKDB\COLMSHOC\SC00102E.PCX (f,g)
E. Models of main shock (f)
1. Broadband digital station records (f)
a. Source model #\SPITAKDB\COLMSHOC\SC00601C.PCX (f,g)
b. Source function #\SPITAKDB\COLMSHOC\SC00601D.PCX (f,g)
c. Scheme of model #\SPITAKDB\COLMSHOC\SC00601E.PCX (f,g)
2. Nearfield station accelerograms (f)

a. East-west component #\SPITAKDB\COLMSHOC\SC00602C.PCX (f,g)
b. North-south component #\SPITAKDB\COLMSHOC\SC00602D.PCX (f,g)
c. Vertical component #\SPITAKDB\COLMSHOC\SC00602E.PCX (f,g)
d. Calc. displacement data #$\SPITAKDB\COLMSHOC\SC00602B.TXT (f,d)
e. Correlation #$\SPITAKDB\COLMSHOC\SC00602F.TXT (f,d)

IV. Aftershocks (f)
A. Regional aftershock maps (f)
1. Network of regional seismic stations #\SPITAKDB\COLSTATI\SC00101C.PCX (f,g)
2. Events measured by regional & temporary stations #$\SPITAKDB\COLMETHO\SC00101B.TXT (f,d)
3. Map of aftershocks #\SPITAKDB\COLMETHO\SC00101C.PCX (f,g)
4. Networks information #$\SPITAKDB\COLSTATI\SC00102A.TXT (f,d)
5. Network of temp. seismic stations #\SPITAKDB\COLSTATI\SC00102C.PCX (f,g)

B. Local aftershock cross-sections (f)
1. Cross-sections - aftershocks swarm (f)
a. Location of sections #\SPITAKDB\COLAFTER\SC00102C.PCX (f,g)
b. Section a'a #\SPITAKDB\COLAFTER\SC00102D.PCX (f,g)
c. Section b'b #\SPITAKDB\COLAFTER\SC00102E.PCX (f,g)
d. Section c'c #\SPITAKDB\COLAFTER\SC00102F.PCX (f,g)
e. Section d'd #\SPITAKDB\COLAFTER\SC00102G.PCX (f,g)
f. Section e'e #\SPITAKDB\COLAFTER\SC00102H.PCX (f,g)
g. Section f'f #\SPITAKDB\COLAFTER\SC00102I.PCX (f,g)
h. Section g'g #\SPITAKDB\COLAFTER\SC00102J.PCX (f,g)
i. Section h'h #\SPITAKDB\COLAFTER\SC00102K.PCX (f,g)
j. Section j'j #\SPITAKDB\COLAFTER\SC00102L.PCX (f,g)

2. Fault plane solutions (f)
a. Individual mechanisms (f)
1. Location of profiles #\SPITAKDB\COLAFTER\SC00401C.PCX (f,g)
2. Fault plane solutions for profile A'A #\SPITAKDB\COLAFTER\SC00401D.PCX (f,g)
3. Fault plane solutions for profile E'E #\SPITAKDB\COLAFTER\SC00401E.PCX (f,g)
4. Fault plane solutions for profile H'H #\SPITAKDB\COLAFTER\SC00401F.PCX (f,g)
5. Fault plane solutions for profile P'P #\SPITAKDB\COLAFTER\SC00401G.PCX (f,g)
b. Composite mechanisms (f)
1. Map of aftershocks zone location #\SPITAKDB\COLAFTER\SC00402C.PCX (f,g)
2. Composite mechanism fault plane solution #\SPITAKDB\COLAFTER\SC00402D.PCX (f,g)
3. Level of composite mechanism regularity #$\SPITAKDB\COLAFTER\SC00402E.TXT (f,g)

3. Radiation patterns (f)
a. Soft and rigid sources (f)
1. Scheme #\SPITAKDB\COLAFTER\SC00503C.PCX (f,g)
2. Section AA' #\SPITAKDB\COLAFTER\SC00503D.PCX (f,g)
3. Legend for section AA' #\SPITAKDB\COLAFTER\SC00503E.PCX (f,g)

b. Spectral characteristics (f)
1. Spectral characteristics of S-waves #\SPITAKDB\COLAFTER\SC00504C.PCX (f,g)
2. Spectral characteristics of codes A100 #\SPITAKDB\COLAFTER\SC00504D.PCX (f,g)
3. Legend for spectral characteristics

#\SPITAKDB\COLAFTER\SC00504E.PCX (f,g)

C. Aftershocks catalog #\SPITAKDB\COLASCAT\spitakas.bin (f,d)

D. Aftershock focal mechanisms and other parameters (f)
1. Velocity model #$\SPITAKDB\COLVELOC\SC00101A.TXT (f,d)
2. Variations of seismic parameters (f)
a. Radiated seismic energy #\SPITAKDB\COLAFTER\SC00201C.PCX (f,g)
b. Seismic activity and fractionality (f)
1. Seismic activity #\SPITAKDB\COLAFTER\SC00202C.PCX (f,g)
2. Fractionality #\SPITAKDB\COLAFTER\SC00202D.PCX (f,g)
c. Morishita index #\SPITAKDB\COLAFTER\SC00204C.PCX (f,g)
3. Time deviations #\SPITAKDB\COLMETHO\SC00101D.PCX (f,g)

V. Impact (f)
A. Factors influencing earthquake impact (f)
1. Rocks and soils (f)
a. Rock distribution (differing densities) #\PCT\IMPACT\ROCKDENS.PCX (f,g)
b. Soil distribution (differing seismic prop.) #\PCT\IMPACT\GROUNDIM.PCX (f,g)
c. Distribution of thickness of Quaternary deposits #\PCT\IMPACT\THICKNESS.PCX (f,g)
d. Dislocation of basement #\PCT\IMPACT\BASE.PCX (f,g)
e. Distribution of exogenous process #\PCT\IMPACT\EXOGENOU.PCX (f,g)

2. Land use (f)
a. Distribution of forests, reserves, and resorts #\PCT\IMPACT\IR20100.PCX (f,g)
b. Distribution of rural settlements #\PCT\IMPACT\IR20301.PCX (f,g)
c. Distribution of settlements with population > 10,000 #\PCT\IMPACT\IR20302.PCX (f,g)
d. Distribution of towns with population >10,000 #\PCT\IMPACT\IR20305.PCX (f,g)

B. Landslides (f)
1. Planar rock slide #\SPITAKDB\COLLANDS\SC00101C.PCX (f,g)
2. Landslide in weathered tuff #\SPITAKDB\COLLANDS\SC00102C.PCX (f,g)
3. Landslide at Nalband (f)
a. View of restored track #\SPITAKDB\COLLANDS\SC00103C.PCX (f,g)
b. Plan and profile views #\SPITAKDB\COLLANDS\SC00103D.PCX (f,g)

C. Fractures, faults, & damage near epicenter (f)
1. Distribution of fracture activity #\PCT\IMPACT\EPICENTE\EFAULTD.PCX (f,g)
2. Distribution of length of faults #\PCT\IMPACT\EPICENTE\EFAULTL.PCX (f,g)
3. Distribution of settlements < 24% damage #\PCT\IMPACT\EPICENTE\ELESS25.PCX (f,g)
4. Distribution of settlements > 25% damage #\PCT\IMPACT\EPICENTE\EMORE25.PCX (f,g)

D. Local conditions & damage in 3 cities (f)
1. Spitak (f)
a. Spitak topography (f)
1. Topography of Spitak area map #\SPITAKDB\COLSPITA\SC00101C.PCX (f,g)
2. Cross section AA'#\SPITAKDB\COLSPITA\SC00101D.PCX (f,g)
3. Cross section BB'#\SPITAKDB\COLSPITA\SC00101E.PCX (f,g)
4. Cross section CC'#\SPITAKDB\COLSPITA\SC00101F.PCX (f,g)
5. Cross section DD'#\SPITAKDB\COLSPITA\SC00101G.PCX (f,g)
6. Legend for Spitak topography map #\SPITAKDB\COLSPITA\SC00101H.PCX (f,g)
b. Distribution of damaged structures #\SPITAKDB\COLSPITA\SC00102C.PCX (f,g)
c. Legend for damaged structures map #\SPITAKDB\COLSPITA\SC00102D.PCX (f,g)
2. Kirovakan (f)
a. Kirovakan location #\SPITAKDB\COLKLOC\SC00101C.PCX (f,g)

b. Natural conditions (f)
1. Geology of Kirovakan (f)
a. Vertical dissection of relief #\PCT\IMPACT\KIROVNEW\K10300.PCX (f,g)
b. Length of active fractures #\PCT\IMPACT\KIROVNEW\K17000.PCX (f,g)
c. Length of inactive fractures #\PCT\IMPACT\KIROVNEW\K17100.PCX (f,g)
d. Length-increased jointing zones #\PCT\IMPACT\KIROVNEW\K17200.PCX (f,g)
e. Total length of fractures #\PCT\IMPACT\KIROVNEW\TOTALLEN.PCX (f,g)
2. Hydrology (f)
c. Technological areas (f)
1. Functional areas (f)
a. Cultural/administrative centers #\PCT\IMPACT\KIROVNEW\KTECHNOG\K20011.PCX (f,g)
b. Forests, landscaped areas #\PCT\IMPACT\KIROVNEW\KTECHNOG\K20014.PCX (f,g)
c. Water table #\PCT\IMPACT\KIROVNEW\KTECHNOG\K20016.PCX (f,g)
d. Distribution of low bldgs. #\PCT\IMPACT\KIROVNEW\KTECHNOG\K20017.PCX (f,g)
e. Distribution of multistory bldgs. #\PCT\IMPACT\KIROVNEW\KTECHNOG\K20018.PCX (f,g)
f. Density of built-up areas #\PCT\IMPACT\KIROVNEW\KTECHNOG\KTDBUI.PCX (f,g)
g. Internal transport zones #\PCT\IMPACT\KIROVNEW\KTECHNOG\K20030.PCX (f,g)
h. External transport zones #\PCT\IMPACT\KIROVNEW\KTECHNOG\K20031.PCX (f,g)
2. Lands (f)
a. Distribution of agricultural lands #\PCT\IMPACT\KIROVNEW\KTECHNOG\K20027.PCX (f,g)
b. Distribution of vacant lands #\PCT\IMPACT\KIROVNEW\KTECHNOG\K20029.PCX (f,g)
d. Damage distribution (f)
1. Low dwelling houses #\PCT\IMPACT\KIROVNEW\KTECHNOG\KDAMLD.PCX (f,g)
2. Multistory buildings #\PCT\IMPACT\KIROVNEW\KTECHNOG\KDAMMB.PCX (f,g)
3. All damaged buildings #\PCT\IMPACT\KIROVNEW\KTECHNOG\K81800.PCX (f,g)
4. Direct losses from bldgs. #\PCT\IMPACT\KIROVNEW\KTECHNOG\K93800.PCX (f,g)
5. Direct losses from zones #\PCT\IMPACT\KIROVNEW\KTECHNOG\K93900.PCX (f,g)

3. Leninakan (f)
a. Distribution of ground water depth 0-2 m #\PCT\IMPACT\KIROVNEW\K13112.PCX (f,g)
b. Distribution of ground water depth 2-5 m #\PCT\IMPACT\KIROVNEW\K13115.PCX (f,g)
c. Distribution of ground water depth 5-10 m #\PCT\IMPACT\KIROVNEW\K13117.PCX (f,g)
d. Distribution of ground water depth 10-20 m #\PCT\IMPACT\KIROVNEW\K13118.PCX (f,g)
e. Distribution of ground water depth >20 m #\PCT\IMPACT\KIROVNEW\K13119.PCX (f,g)
f. Groundwater depth before eq. #\PCT\IMPACT\KIROVNEW\K13300.PCX (f,g)
g. Groundwater depth after eq. #\PCT\IMPACT\KIROVNEW\K13400.PCX (f,g)
h. Changes of groundwater depth #\PCT\IMPACT\KIROVNEW\LEVELUT.PCX (f,g)
i. Groundwater level before eq. #\PCT\IMPACT\KIROVNEW\K18100.PCX (f,g)

j. Groundwater level after eq. #\PCT\IMPACT\KIROVNEW\K18200.PCX (f,g)

E. Damage statistics (f)
1. Location of towns #\SPITAKDB\COLBUILD\SC00101C.PCX (f,g)
2. Spitak #$\SPITAKDB\COLBUILD\SC00101D.TXT (f,d)
3. Stepanavan #$\SPITAKDB\COLBUILD\SC00101E.TXT (f,d)
4. Kirovakan #$\SPITAKDB\COLBUILD\SC00101F.TXT (f,d)
5. Akhuryan #$\SPITAKDB\COLBUILD\SC00101G.TXT (f,d)
6. Dzaghgahovid #$\SPITAKDB\COLBUILD\SC00101H.TXT (f,d)
7. Kalinino #$\SPITAKDB\COLBUILD\SC00101I.TXT (f,d)
8. Leninakan #$\SPITAKDB\COLBUILD\SC00101J.TXT (f,d)
9. Aparan #$\SPITAKDB\COLBUILD\SC00101K.TXT (f,d)
10.Artik #$\SPITAKDB\COLBUILD\SC00101L.TXT (f,d)
11.Gukasyan #$\SPITAKDB\COLBUILD\SC00101M.TXT (f,d)
12.Amasia #$\SPITAKDB\COLBUILD\SC00101N.TXT (f,d)
13.Pemzashen #$\SPITAKDB\COLBUILD\SC00101O.TXT (f,d)
14.Maralik #$\SPITAKDB\COLBUILD\SC00101P.TXT (f,d)
15.Alaverdi #$\SPITAKDB\COLBUILD\SC00101Q.TXT (f,d)
16.Dilizhan #$\SPITAKDB\COLBUILD\SC00101R.TXT (f,d)
17.Charentsavan #$\SPITAKDB\COLBUILD\SC00101S.TXT (f,d)
18.Talin #$\SPITAKDB\COLBUILD\SC00101T.TXT (f,d)
19.Razdan #$\SPITAKDB\COLBUILD\SC00101U.TXT (f,d)
20.Ashtarak #$\SPITAKDB\COLBUILD\SC00101V.TXT (f,d)
21.Sevan #$\SPITAKDB\COLBUILD\SC00101W.TXT (f,d)
22.Abovyan #$\SPITAKDB\COLBUILD\SC00101X.TXT (f,d)
23.Idzhevan #$\SPITAKDB\COLBUILD\SC00101Y.TXT (f,d)
24.Gugark #$\SPITAKDB\COLBUILD\SC00101Z.TXT

F. Engineering aspects (f)
1. Engineering seismological aspects (f)
a. Response spectra characteristics (f)
b. Aftershocks records patterns #\SPITAKDB\COLESEIS\SC00102C.PCX (f,g)
c. Angles of emergence of seismic rays #\SPITAKDB\COLESEIS\SC00101C.PCX (f,g)
2. Performance of engineered structures (f)
a. Histogram of damage #\SPITAKDB\COLCOMME\SC00101C.PCX (f,g)
b. Stone masonry bearing wall bldgs. (f)
1. Typical damage (f)
a. Damage to stone masonry bldgs #\SPITAKDB\COLSTONE\SC00101C.PCX (f,g)
b. Building that lost its end wall #\SPITAKDB\COLSTONE\SC00101D.PCX (f,g)
c. Building with one entire end collapsed #\SPITAKDB\COLSTONE\SC00101E.PCX (f,g)
2. Collapsed stone masonry building #\SPITAKDB\COLSTONE\SC00102C.PCX (f,g)
3. Damage to composite building #\SPITAKDB\COLSTONE\SC00103C.PCX (f,g)
4. Undamaged building #\SPITAKDB\COLSTONE\SC00104C.PCX (f,g)
c. Precast concrete frame buildings (f)
1. Damage to nine story buildings (f)
2. Collapsed precast-concrete stair elements #\SPITAKDB\COLPRECF\SC00102C.PCX (f,g)
d. Precast large-panel buildings (f)
1. Panorama #\SPITAKDB\COLPANEL\SC00101C.PCX (f,g)
2. Nine-story panel building #\SPITAKDB\COLPANEL\SC00101D.PCX (f,g)
3. Five-story panel building #\SPITAKDB\COLPANEL\SC00101E.PCX (f,g)
e. Lift slab buildings #\SPITAKDB\COLSLAB\SC00101C.PCX (f,g)
f. Industrial facilities (f)
1. Masonry bearing wall buildings #\SPITAKDB\COLINDUS\SC00101C.PCX (f,g)
2. Precast concrete frame buildings #\SPITAKDB\COLINDUS\SC00102C.PCX (f,g)

3. Spitak flour mill (f)
    a. Concrete shear wall structure #\SPITAKDB\COLINDUS\SC00104C.PCX (f,g)
    b. Cast-in-place concrete silo #\SPITAKDB\COLINDUS\SC00104D.PCX (f,g)
4. Destroyed equipment (f)
    a. Leninakan textile factory #\SPITAKDB\COLINDUS\SC00103C.PCX (f,g)
    b. Spitak sugar refinery #\SPITAKDB\COLINDUS\SC00103D.PCX (f,g)

VI. Elements of prediction (f)
- A. Seismological precursors (f)
    1. Diagnosis by the algorithm M8 (f)
        a. On basis of Catalog for 1962-1983 #\SPITAKDB\COLPREDI\SC00401C.PCX (f,g)
        b. On basis of Catalog for 1962-1986 #\SPITAKDB\COLPREDI\SC00401D.PCX (f,g)
        c. Legend for M8 algorithm graphics #\SPITAKDB\COLPREDI\SC00401E.PCX (f,g)
    2. Map of expected earthquakes in 1986-1990 #\SPITAKDB\COLPREDI\SC00402C.PCX (f,g)
    3. Spatial-temporal distribution of eq. precursor #\SPITAKDB\COLPREDI\SC00403C.PCX (f,g)
- B. Hydrodynamic precursors #\SPITAKDB\COLPREDI\SC00102C.PCX (f,g)
- C. Deformation precursors #\SPITAKDB\COLPREDI\SC00103C.PCX (f,g)
- D. Electro-magnetic precursors #\SPITAKDB\COLPREDI\SC00104C.PCX (f,g)
- E. Biological precursors #\SPITAKDB\COLPREDI\SC00105C.PCX (f,g)

VII. NGDC Photos Spitak Earthquake Damage (f)
- A. Collapsed Stone Masonry Bearing-Wall, Alivar #\NGDCPCX\64701101.PCX (f,g)
- B. Collapsed Structures, Alivar #\NGDCPCX\64701102.PCX (f,g)
- C. Collapsed Stone Masonry Building, Alivar #\NGDCPCX\64701103.PCX (f,g)
- D. Collapsed Masonry Building, Arevashok #\NGDCPCX\64701104.PCX (f,g)
- E. Collapse of Composite Structure, Spitak #\NGDCPCX\64701105.PCX (f,g)
- F. Damage to Sugar Beet Refinery, Spitak #\NGDCPCX\64701106.PCX (f,g)
- G. Damage to Flour Mill Complex, Spitak #\NGDCPCX\64701107.PCX (f,g)
- H. Damage to Granary Spitak #\NGDCPCX\64701108.PCX (f,g)
- I. Damage to Communications Building, Spitak #\NGDCPCX\64701109.PCX (f,g)
- J. Partial Collapse of Masonry Building, Spitak #\NGDCPCX\64701110.PCX (f,g)
- K. Partial Collapse of Masonry Building, Spitak #\NGDCPCX\64701111.PCX (f,g)
- L. Collapse of Stone Masonry Building, Spitak #\NGDCPCX\64701112.PCX (f,g)
- M. Damage to Central Spitak #\NGDCPCX\64701113.PCX (f,g)
- N. Damage Concrete-Frame Building, Leninakan #\NGDCPCX\64701114.PCX (f,g)
- O. Collapse of Floors, Leninakan #\NGDCPCX\64701115.PCX (f,g)
- P. Collapse of Masonry Church, Leninakan #\NGDCPCX\64701116.PCX (f,g)
- Q. Earthquake-induced Landslide, Alivar #\NGDCPCX\64701117.PCX (f,g)
- R. Iceberg Produced by Broken Pipe near Spitak #\NGDCPCX\64701118.PCX (f,g)
- S. Thrust fault #\NGDCPCX\64701119.PCX (f,g)
- T.Right-lateral Strike Slip Fault near Spitak #\NGDCPCX\64701120.PCX (f,g)

Chapter 5: ACKNOWLEDGMENTS

PROGRAM SUPPORT

GeoVu was developed with funding support from NOAA's Climate and Global Change Program and from NOAA's Earth System Data and Information Management (ESDIM) Program.

STAFF CREDITS

Many workers in the National Oceanic and Atmospheric Administration were involved in the preparation of the GeoVu access software:

Project Authorization:	Herb Meyers
Project Management:	Ray E. Habermann, and Allen M. Hittelman
CD-ROM Data Preparation:	Patricia A. Lockridge
Access Software:	Ray E. Habermann, Deborah Sinay, Liping Di, and Allen M. Hittelman
CD Face Design:	Joy Ikelman
Documentation:	Allen M. Hittelman, Ray E. Habernann, and Patricia Lockridge

ACKNOWLEDGMENTS

The authors have benefited greatly from comments and support of Academician N.P. Larerov, vice-president of Russian Academy of Sciences. In addition to the authors listed above, information for the Database was made available by V.V. Shteinberg, B.A. Borisov, B.M. Graizer, L.A. Delitsin, S.G. Molotkov, I.E. Parshin, K.G. Pletnev, P.A. Aleksin, A.A. Romanov, D.E. Loshtanov, I.S. Aptekman, T.V. Afimmmmm'ena, N.E. Shilova, and N.V. Shebalin of the Institute of the Physics of the Earth, RAS; V.I. Kelis-Gorok, V. Kosobokov, A.V. Lander, O.D./ Voevoda, of the International Institute of Earthquake Prediction and Mathematical Geophysics; G.L. Koff, Institute

of Lithosphere, RAS; A. Cisternas, IPG, Strasburg, France; H. Philip, J.C. Bousquet, L. Dorbath, C. Porbath, L. Rivers, A. Nercessian, H. Hessler, J. Traupert, G. Boll, M. Diament, H. Blumentritt Institut de Physique du Globe de Paris, France; J.S. Filson, National Earthquake Information Center, U.S. Geological Survey, USA.

The record of the mainshock in Gukasyan was recorded by the scientists of the Instiltute of Seismology of Armenian Academy of Sciences.

The authors are grateful to F.M. Christie, Editorial Coordinator of magazine "Earthquake Spectra" for kind permission to scan a portion of the American Earthquake Reconnaissance Report into this Database.

The authors would like to thank G. Ivanova, E. Maksimova, A. Melkumyan, L. Zaborinskaya for assistance.

This work was supported by the grant of the Commission for IDNDR of IASPEI.