The ING Seismic Network Databank (ISND): a friendly parameters and waveform database

Salvatore Barba, Rita Di Giovambattista and Giuseppe Smriglio
Istituto Nazionale di Geofisica, Roma, Italy

Abstract
The Istituto Nazionale di Geofisica (ING) Seismic Network Database (ISND) includes over 300000 arrival times of Italian, Mediterranean and teleseismic earthquakes from 1983 to date. This database is a useful tool for Italian and foreign seismologists (over 1000 data requests in the first 6 months of this year). Recently (1994) the ING began storing in the ISND, the digital waveforms associated with arrival times and experimentally allowed users to retrieve waveforms recorded by the ING acquisition system. In this paper we describe the types of data stored and the interactive and batch procedures available to obtain arrival times and/or associated waveforms. The ISND is reachable via telephone line, P.S.I., Internet and DecNet. Users can read and send to their E-mail address all selected earthquakes locations, parameters, arrival times and associated digital waveforms (in SAC, SUDS or ASCII format). For medium or large amounts of data users can ask to receive data by means of magnetic media (DAT, Video 8, floppy disk).

Key words *seismic network – waveform – database*

1. Introduction

This article deals with a seismic database developed to encourage both communication and data exchange among seismic data centers. Differently from the past when only the parametric information concerning the seismic events was utilized, nowadays the new methodologies adopted in seismology require all the seismic information contained in the digital waveforms which only a well furnished databank can provide.

The diffusion of computer networks has increased data requests. Consequently the data centers have been forced to tackle the problem of their increased workload.

The most qualified main international research centers have dealt with the problem by organizing easy access databanks from which it is possible to retrieve seismic data in different standard formats (Kradolfer, 1993; Romanowicz et al., 1994).

In order to ease the management of the Italian Telemetered Seismic Network (ITSN) data, we developed a new database divided into two sections: parametric information and waveform containing the whole digital seismogram.

The digital recording of a seismic event is difficult to store in existing database for two main reasons: first because the memory requested is unknown *a priori* and secondly because it must be treated using a code able to deal with variable length information. Furthermore the database must be relational, that is, able to optimize the stored information while having an efficient dynamic link. This is a consequence of the variety of information which must be present at one time in a seismic database.

The following aims were pursued in developing the ISND: first, the data format was de-

signed to be as simple as possible according to the necessity of managing many kinds of data recorded by different local networks; second, standards which are independent from the specific devices as well as transmission systems are available, thus simplifying data exchange. The most common formats in use in the seismic community are available: the interrogation of the database is simple and generic and on line help is available to the user.

2. ISND data

The ISND data are collected by the ITSN which has undertaken a seismological development during the last ten years. This development included the data processing system both in the seismological automatic procedures and in the detection and communication ability (fig. 1). The ITSN is composed of about 80 seismic stations equipped with the Teledyne Geotech S-13 seismometers characterized by an eigenfrequency of 1 Hz and acting at a critical dumping of 70% (fig. 2).

The signals are transmitted over telephone lines or radio relay systems and subsequently demodulated and acquired by an automatic acquisition system developed in 1984 in cooperation with the United States Geological Survey (USGS). The acquisition takes place on two parallel computers, a Vaxlab and a Vax 9000. A Preston performs the A/D conversion of the seismograms (12 bit plus sign) with the sampling rate of 50 sps. Digital data are stored on a magnetic disk and then retrieved to be processed by interactive procedures on graphic terminals.

The automatic picking of the seismic phases is checked daily and if necessary corrected by seismic analysts who also recognize other phases well identifiable on the seismograms. The reviewed data are then automatically associated and the events are relocated.

Within a week, depending on the rate of seismic activity, parametric and digital data will be available at ISND.

In the last few years new procedures have been developed allowing the immediate exchange of parametric information derived from
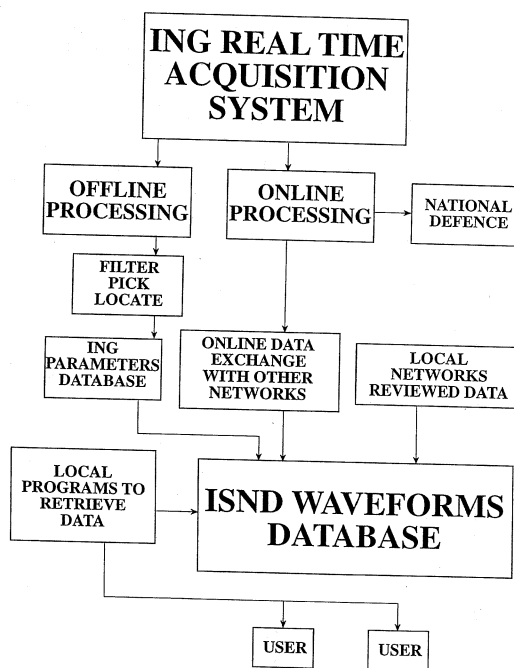

Fig. 1. Automated procedures at the ISND.

the automatic processing of the ISND. Through automatic procedures running on the ING real time acquisition system the arrival times for Mediterranean earthquakes of magnitude greater than or equal to 4.0 are sent to the NEIC (National Earthquake Information Center) and to the EMSC (Euro Mediterranean Seismological Center). Resulting from this cooperation the NEIC sends the ING data center daily three types of messages containing earthquake parameters: the first within one hour from an earthquake (alert messages), quick epicentral determinations and preliminary determinations. This parametric information is also stored in the ISND.

At present all hypocentral determinations and arrival times of the last ten years recorded by the ITSN are available.

The digital waveform data are composed of two main parts: a volume header and a data group. Together they form a waveform exchange packet.
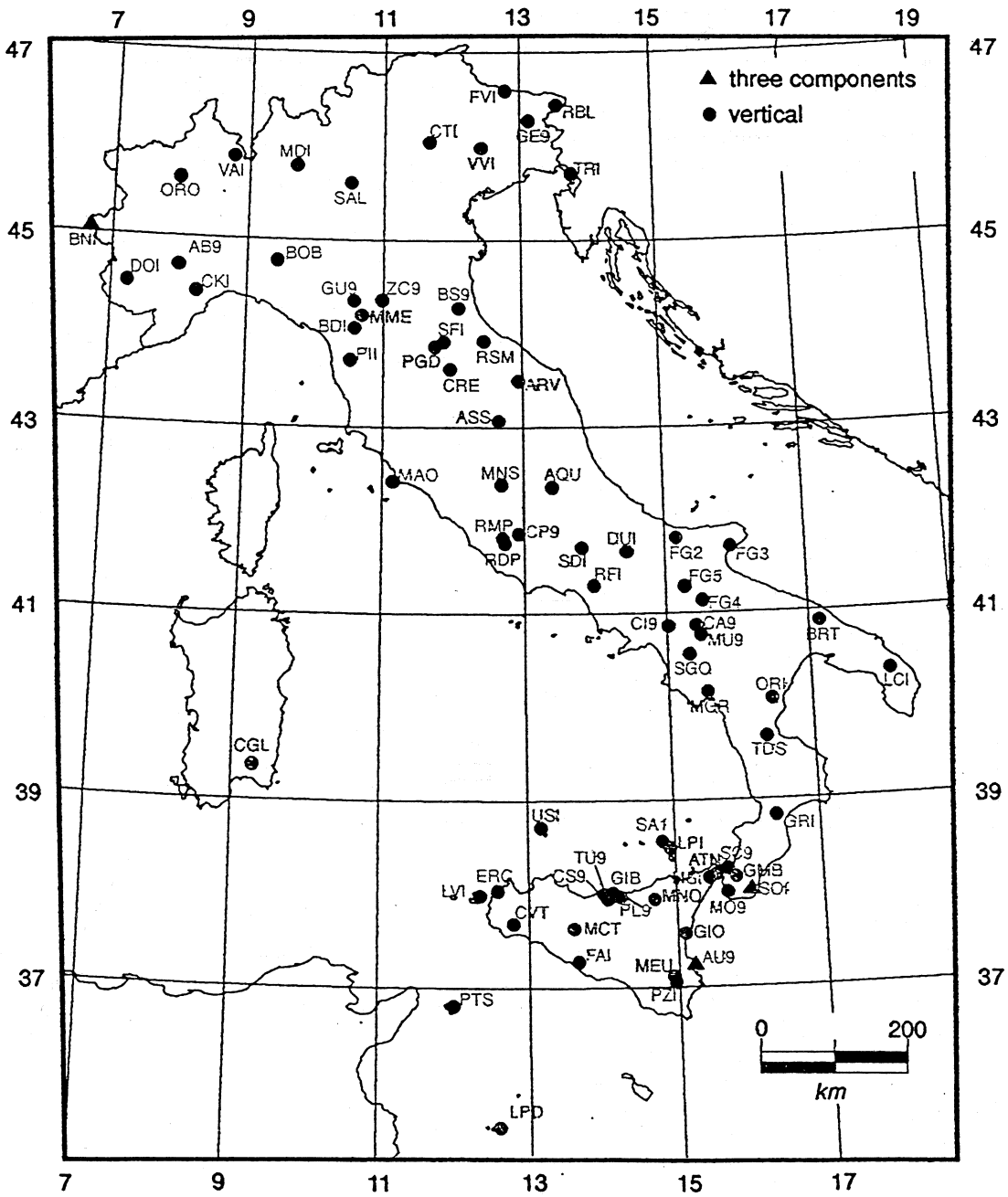
Fig. 2. Italian Telemetered Seismic Network.

The header contains the following fields:

– information belonging to each waveform (station code, component, absolute time of the signal, sampling rate and so on);
– information concerning the signal (waveform with the associated phases, waveforms which contribute to a hypocenter location);
– focal parameters associated with the waveform (hypocentral coordinates, origin time);
– information on data storage (format, device, label of the device, name and address of the file), device status (on line or to be mounted).

3. Procedures for data access

The ISND is reachable via telephone line, P.S.I., Internet and DecNet.
When the user enters the databank a user information screen is presented (fig. 3). An account may be requested by new users. The user must fill in each of the blanks. All entries and answers are recorded on a file.

If the user does not answer one of these questions, access is denied and the computer link stopped. Upon logging in the user will receive information regarding his account.

4. Data structure

In order to devise a relational database able to manage variable length records the following path must be pursued. The first step consists of the determination of the necessary information to be recorded. An efficient data management by pointers optimizes the standard information. Parametric information is organized in fixed length records. This allows rapid and efficient access to the basic information concerning the recording of the seismic events (stations, kind of stations, phases, event location etc.). The second step was the definition of a type of «event», *i.e.* a kind of datum, at variable length, able to contain not only the recordings of the seismic events but also the main characteristics of the recording itself (sampling rate etc.).

Add New User

Preferred User Identification

User Full Name

Institution
Institution Address

Institution Ph. no.
Alternate Ph. no.
Fax no.
E/Mail Address
Alternate E/Mail

Accept ?   Y

Press <PF2> for Help, <Enter> to Execute, <Keypad 0> to quit

Fig. 3. ISND user information screen.

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ING Data Request Management

                        MAIN Menu

        CREATE      Create or modify a data structure

        DETECT      Show parameter data (N/A)

        WAVEF       Extract data from available structures

        USER        Create or modify user setup (N/A)

        EXIT        Exit

                                        Press <PF2> for help

Choice [EXIT]:
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Fig. 4. ISND main menu.

Such solution permits the management of variable length records and the integration among different recording formats of seismic events by means of a mark (sign) inside the kind of event. This organization integrates data coming from other networks and recorded by different seismometers. In particular, this configuration allows the management of both data collected by ITSN and those coming from local or temporary networks.

A third step has been to implement the system with a strong structure making it flexible in the management and updating of the system.

The result of this is the ability to insert in the database different information, such as, for example the transfer functions of the stations. A further relevant characteristic is the possibility to implement such a database on different operating systems.

5. Utilities

Data can be retrieved through self-explanatory menus. Entering the ISND, a first menu (main menu, see fig. 4) is displayed to the user giving access to the following possible options:

the first one (CREATE) reserved for internal use and another one (USER) used to obtain the necessary information concerning the devices at the user's disposal (*i.e.* terminal, mass memory, communication systems). This information will be used by the ISND manager to choose the appropriate support and communication links to send the required data; the (DETECT) option allows access to the parametric information of an earthquake following the available selection criteria, thus entering the associated digital waveforms.

All the waveforms can be extracted directly from the WAVEFORM option, which allows access to a second menu (waveform management) (fig. 5). During the waveform selection option a file containing all the parameters identifying the waveforms is created. The (REPORT) command lists the parametric information stored in the file while the digital waveforms can also be displayed on a video terminal (fig. 6).

By the (GETWAVE) command each waveform can be directly selected or first displayed; the (MOVE) utility can be used to transfer the selected data to an open account from which the user can decide to copy them by means of an *FTP* utility or if required transfer them
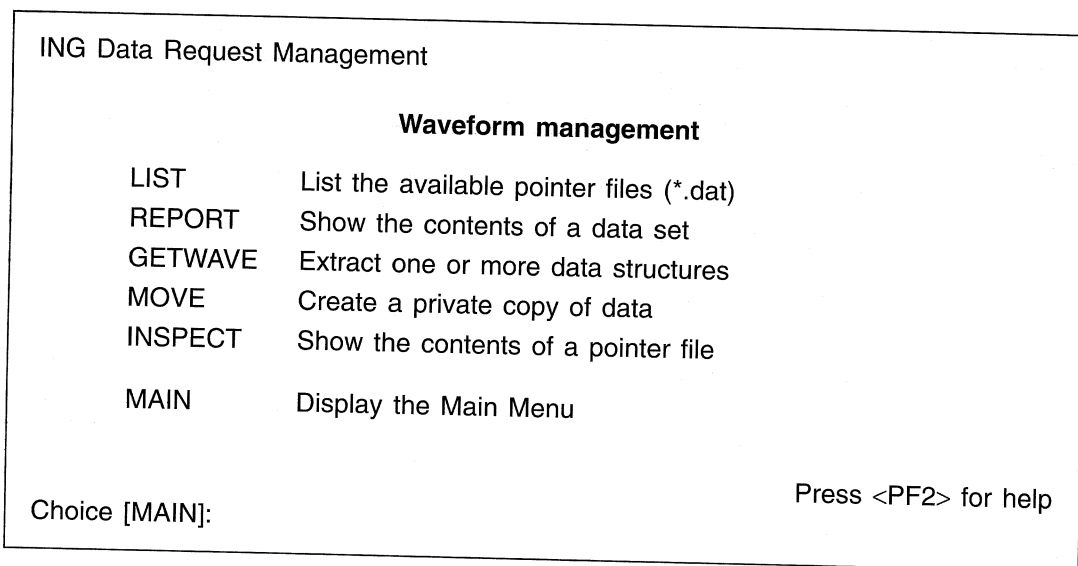
ING Data Request Management

Waveform management

LIST   List the available pointer files (*.dat)
REPORT   Show the contents of a data set
GETWAVE   Extract one or more data structures
MOVE   Create a private copy of data
INSPECT   Show the contents of a pointer file

MAIN   Display the Main Menu

Choice [MAIN]:   Press <PF2> for help

Fig. 5. ISND waveform management menu.

Get Waveform Utility

Pointer File (to be specified)

Readonly   Y   Output file:

Show   Y   report file: report.dat

Plot   <When required>
Pick   N
Desampling   N   Ratio:
Work. Type   16   Graphic file sys$output
Wait   N

Accept ?   Y

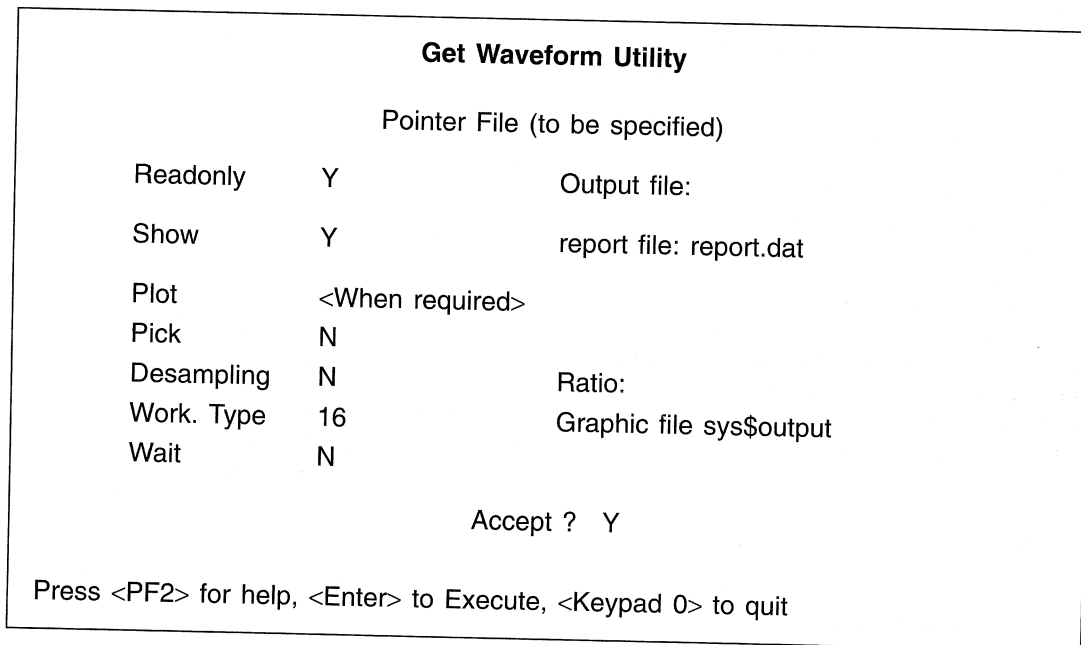Press <PF2> for help, <Enter> to Execute, <Keypad 0> to quit

Fig. 6. A ISND waveform management utility.

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to the available devices. The last command INSPECT, only for internal use, inspects the contents of the pointer file and edits the waveform header in order to modify all the defined fields.

An on line general help and a specific help for each procedure is available.

The ISND includes utilities to select parameters and waveforms.

The following main options are available to select the parameters:

– **S** to select locations from ING hypocentral determination summary;
– **T** to extract the selected station arrival times with phase option from ING arrival times;
– **F** to extract names, codes and coordinates from Mediterranean station file. It is also possible to extract the stations in a range of coordinates;
– **N** the ING, according to National Earthquake Information Center (NEIC), includes in ISND also NEIC hypocentral determinations and names and coordinates of all worldwide international seismic stations. With this option it is possible to extract these data using some selection criteria.

The waveform management menu is structured in 5 options. Reading arrival times (REPORT option), the user can select the associated waveforms (GETWAVE option). By means of this utility the user can display the waveforms, select them and choose to obtain them or not. The procedure asks the user to choose the format. The marked waveforms are copied by means of the MOVE utility on an open account where the files are available for 24 hours. During this time the user can access and copy them via *FTP*.

6. Format for data exchange

In developing the internal proposed format, several objectives were pursued. First, the format was kept as simple as possible, consistent with the need to handle a wide variety of waveform types coming from many local networks. Second the overall format was developed to be independent from specific devices and transmission media to facilitate exchange through all means of communication. In addition the most useful formats in use at the other institutes, such as *SAC* and *SUDS*, are available.

7. Future developments

Some other utilities such as an Auto Data Request Manager (DRM) have been planned but are not in use yet. An Auto DRM using E-mail exchange to disseminate data could enormously increment the number of researchers who can benefit from a well organized databank.

8. Getting support

For a user's guide and related databank documents, contact Salvatore Barba and Rita Di Giovambattista, Istituto Nazionale di Geofisica, Via di Vigna Murata 605, 00143 Rome, Italy; e-mail barba@in8800.ingrm.it or digiovam@in8800.ingrm.it.

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