

PREVIEW ON REFRACTION DATA PROCESSING IN WESTERN BOHEMIA

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ABSTRACT. Refraction measurements in a seismically active part of the Bohemian Massif were carried out in the years 1989, 1990 and 1991. Processing of gathered data was performed by various institutions. We propose a methodology with appropriate software layout that can extract useful information from refraction field measurements for the next processing step – 3D seismic tomography.

INTRODUCTION

Western part of the Bohemian Massif exhibits increased seismic activity, expressed by a repeated occurrence of earthquake swarms recorded on the territory of Western Bohemia and the adjacent Saxon and Bavarian regions in Germany. Local network WEBNET of digital seismic stations was established with a view of comprehensive seismic investigations in this region [Boušková et al., 1994]. Altogether six epicentral areas were identified, in which foci of microearthquakes are clustered. Simple models, homogeneous half-space with one surface layer, are used to locate seismic events [Horálek et al., 1994].

Four 2D velocity sections have been obtained by means of 2D refraction tomography along A/89, B/89, C/91 and D/91 profiles. A preliminary 3D velocity model based on 2D sections, and both geological and geophysical data, was assembled [Dvořák and Sýkorová, 1993]. There are problems to determine 3D velocity model by using seismic inversion due to the lack of data and necessity of theory, algorithms and computer code for 3D seismic refraction tomography [Bucha et al., 1992]. The aim of this paper dealing with refraction data processing is to show how input data from field measurements can be prepared for 3D seismic tomography.

REFRACTION DATA PROCESSING

Field refraction measurements in Western Bohemia yielded a great amount of data. The flow chart of the data processing that was used in the Institute of Rock Structure Mechanics is presented in Figure 1. The chart was proposed by Luděk Klimeš (now Institute of Geophysics, Charles University in Prague) and Václav Bucha and can be utilized for future measurements.

Field measurements include seismic recording of exploratory explosions and other kinds of seismic signal (e.g. quarry blasts) on condition that we know precisely the time of origin. In our case we participated, jointly with the Geophysical Institute on measurement of shots from MVE/90, C/91 and D/91 profiles [Bucha et al., 1992]. As given in Figure 1, the data **preprocessing** follows. Raw field data are stored on a 0.25 inch magnetic tapes (Lennartz Electronic 5800 PCM systems) or 3.5 inch floppy disks (LE MARS88 FD systems). It is necessary to convert raw field data to standard binary or ASCII files for next processing. The converted data are sorted and stored on a fast storage medium (e.g. hard disk) primarily on PC computers. The files are sorted according to measurement points, date and denotation of measurement device. Other data about shots, measurement points and topography are collected.

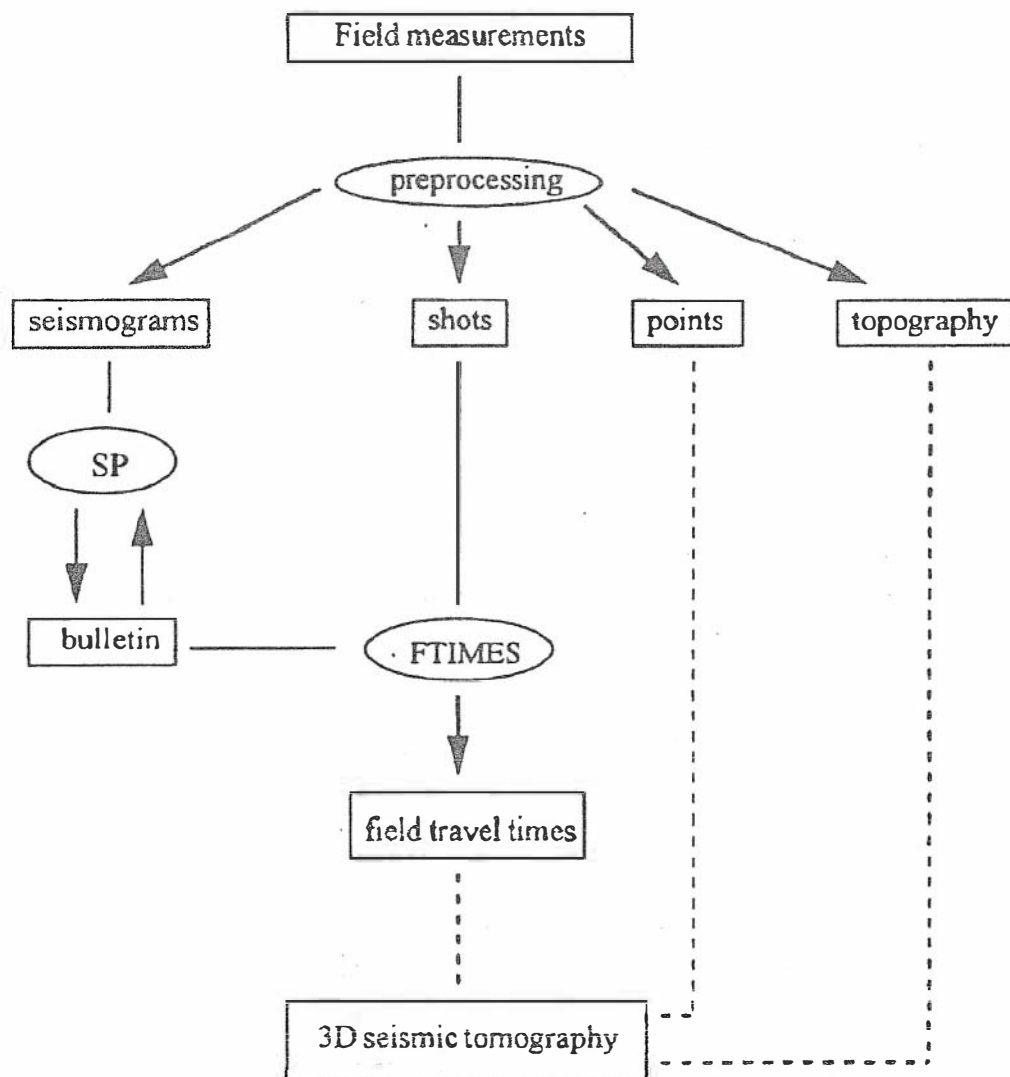


FIGURE 1. Flow chart of the data processing

Digital **seismograms** are interactively viewed. Input file for interactive program **SP** (Signal Processing) is denoted “*name of file.BLT*” that can be prepared by a standard editor (e.g. PE2, Brief) and the structure of the input file for the FORTRAN77 list-directed (free format) input should be:

```

1. line:  'description of variables (C)'/
2. line:  'path to signal file from current directory(C)' 'name of shot point(C)'
          'name of receiver point(C)' 'wave(C)' 'date(C)' seconds(R) error(R)
          amplitude1(R) amplitude2(R) amplitude3(R) / comment
          ...
example: 'ID58\TIS9009.BIN\09151015.05C' 'MVE+102' 'FIX-TIS' 'P'
          '90.09.15 10:15' 12.082 .004 2.8000 .800 1.100 /
          ...
last line: /

```

where (R) is real and (C) is character data type. A slash encountered as a value separator during execution of a list-directed input statement causes termination of execution of that input statement after the assignment of the previous value. If there are additional items in the input list, the effect is as if null values had been supplied for them [ANSI X3.9-1978]. Text written in *italic* type should be replaced by actual names.

The file “*name of file.BLT*” have to contain only first three strings. Remaining variables are filed up or updated during the interactive view of seismograms. We pick arrival times, estimate their accuracy, examine for mistakes, assess the quality of recordings. Seismic noise and signal to noise ratio are important parameters for the future field measurements. They help us to evaluate the quality of measurement point. The output of processing seismograms is **bulletin** (updated file “*name of file.BLT*”). The interactive program **SP** is written in FORTRAN77 and uses graphical standard GKS (Graphical Kernel System) [ANSI X3.124-1985] library. MS DOS version is used and MS Windows version is prepared (GKS library is available for various operating platforms). The program can be simply extended to utilize prepared subroutines that were developed for previous VDI graphical version (seismogram integration, notch filtration, spectral analyse and particle motion analysis).

The other output of preprocessing according to Figure 1 is a detection of data about **shots**. Names of shots, coordinates (all in Krovak coordinate system) and times of origin are the minimum what we have to know. Information about charge, minimum and maximum depth of shots is also useful for next measurements. The structure of the file “*name of file.SHT*” (FORTRAN77 list-directed format) should be:

```

1. line:  'description of variables(C)' /
2. line:  'name of shot(C)' 'date(C)' seconds(R) / comment
          ...
example: 'C91+C1/2' '91.07.05 12:00' 10.000 / 1 × 70 1 × 28 1 × 18
          ...
last line: /

```

Names, coordinates and comments of both shot and receiver **points** are stored in the file "*name of file.PTS*" and the structure (FORTRAN77 list-directed format) should be:

```

1. line:  'description of variables(C)' /
2. line:  'name of point(C)' coordinate1(R) coordinate2(R)
          coordinate3(R) / comment
          ...
example: 'FIX-KMH' 890.082 1019.207 .486 / Komorni hurka W6 36-55
          ...
last line: /

```

Topography files contain valuable terrain data about investigated area for constructing various maps. They include coordinates and names of cities, rivers, border-line etc. Coordinates about surface of area (X, Y, Z Krovak coordinates) are digitized with step 1 km. These data will be utilized in rendering of 3D seismic models [Bucha, 1994]. The structure of topography files "*name of file.TPG*" is simple and similar to shots and points files (FORTRAN77 list-directed format), so it is not necessary to write an examples.

Simple FORTRAN77 program **FTIMES** determines **field travel times** between sources and receivers for selected wave. There are two files on input: "*name of file.SHT*" and "*name of file.BLT*". The output file containing field travel times "*name of file.FTT*" (FORTRAN77 format) has following structure:

```

1. line:  'description of variables(C)' /
2. line:  'name of shot (C)' 'name of receiver(C)' field travel time(R) error(R)
          ...
example: 'C91+C1/1' 'TMP-ARN' 4.920 .012
          ...
last line: /

```

The file "*name of file.FTT*" is input for other programs, e.g. generating source and receivers coordinates for a ray tracing program, evaluating the derivatives of the

travel times with respect to the model coefficients, generating the list of synthetic travel times.

CONCLUSION

Proposed method of refraction data processing in Western Bohemia was presented. The advantage of the software layout is a relative system independence due to ANSI standards used. The data files can be transferred to other operating systems with small changes. The system of processing data is not interactive with exception of SP (Signal Processing) program. The input data files are written in FORTRAN77 list-directed format, but do not comply with seismic bulletin standards. The scheme of refraction data processing is closely related to 3D seismic tomography, that is under development, that is why the proposal of refraction data processing could be changed in the next future. The aim of refraction seismic tomography in Western Bohemia is a construction of seismic model of 3D inhomogeneous geological structures.

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