Abstract
A number of regional refraction seismic experiments were performed on the territory of the Czech Republic recently. These experiments have produced a relatively great amount of new data. Older data with a comparable quality exist as well. It is definitely advantageous to process and interpret all available data jointly, and to compare current and previous results. According to our experience technical obstacles cause not using all existing data systematically: particular data sets are difficult to obtain and differences in their formats are also significant. The goal of our work was to create a homogeneous database containing times of propagation of nearly all seismic experiments performed on the territory of the Czech Republic, and measured with digital technology.

Introduction
The subject of this paper is to describe our work aiming at collecting the times of propagation of seismic phases from different active seismic experiments and at consecutive unifying of these data. We have considered all available refraction seismic experiments performed on a regional scale, covering at least partially the region of the Czech Republic and using digital measurement technology. Such experiments may be roughly characterised by the following:

- seismic waves are generated by firing of $\sim 10^2$ kg of explosive
- the measuring geometry is linear
- the distance between closest shot-points is $\sim 10^1$ km
- the distance between closest receivers is $\sim 10^0$ km
- sampling period is 4-50 ms
- $P_g$, $P_n$ and $P_mP$ phases are picked in the epicentral range 0–250 km.

We have compiled data from experiments listed in the following table.

<table>
<thead>
<tr>
<th>Name of the experiment</th>
<th>Measured in</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dekorp 3 shots recorded on the Czech territory</td>
<td>1990</td>
<td><a href="http://www.gfz-potsdam.de/pb3/dekorp/welcome.html">www.gfz-potsdam.de/pb3/dekorp/welcome.html</a></td>
</tr>
<tr>
<td>Celebration 2000</td>
<td>2000</td>
<td>Guterch et al.2003a</td>
</tr>
<tr>
<td>Celebration 2000 shots recorded by CRNS*</td>
<td>2000</td>
<td>Málek et al.2001</td>
</tr>
<tr>
<td>Mining induced events in Ostrava coal mines</td>
<td>2000-2003</td>
<td>Růžek et al.2003</td>
</tr>
<tr>
<td>Alp 2002 receivers used for recording a big shot in a circular configuration</td>
<td>2002</td>
<td>Hrubcová et al.2004</td>
</tr>
<tr>
<td>Alp 2002</td>
<td>2002</td>
<td>Vavryčuk et al.2004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zedník et al.2004</td>
</tr>
</tbody>
</table>
All these data are inhomogeneous due to more reasons. Co-ordinates may be either geographical (\(\varphi, \lambda\)) or local cartesian (X,Y). Times of propagation may be either given directly, or times of arrivals plus shooting time are defined. It may not be evident, which phases were picked. The precision depending also on the sampling rate of original recordings may be different. The particular digital format of original waveform data is definitely individual for each source of data. For all this reasons, archive data are not used appropriately. We tried to collect all these data and to homogenize them. We have created database tables sharing an unique format. We believe, that now the utilization of corresponding information is easy and straightforward. All tables are accessible on request via e-mail b.ruzek@ig.cas.cz. Nevertheless, we know that our database is still incomplete and it has to be upgraded in the future. Recently, the most appropriate source of data is the sequence of BOHEMA experiments (e.g. Babuška et al. 2003). These data will be definitely included as soon as possible, depending on the agreement of the research team managing the data.

**Database Structure**

Our database is very simple in fact. It consists of three related tables: (i) table of shots, (ii) table of stations/receivers, and (iii) table of readings.

Example of three lines of the table of shots:

<table>
<thead>
<tr>
<th>ID</th>
<th>FI</th>
<th>LAMDA</th>
<th>Z</th>
<th>Y</th>
<th>X</th>
<th>YR</th>
<th>MO</th>
<th>DATE</th>
<th>HR</th>
<th>MIN</th>
<th>SEC</th>
<th>CHRG</th>
</tr>
</thead>
<tbody>
<tr>
<td>26910</td>
<td>50.2167</td>
<td>12.6683</td>
<td>399</td>
<td>864.648</td>
<td>1010.350</td>
<td>2000</td>
<td>6</td>
<td>25</td>
<td>3</td>
<td>15</td>
<td>0.113</td>
<td>200</td>
</tr>
<tr>
<td>26901</td>
<td>50.5631</td>
<td>13.7252</td>
<td>220</td>
<td>784.508</td>
<td>983.738</td>
<td>2000</td>
<td>6</td>
<td>24</td>
<td>3</td>
<td>45</td>
<td>1.295</td>
<td>10710</td>
</tr>
<tr>
<td>20030</td>
<td>47.4262</td>
<td>14.5148</td>
<td>1448</td>
<td>776.207</td>
<td>1337.237</td>
<td>2000</td>
<td>6</td>
<td>24</td>
<td>3</td>
<td>0</td>
<td>0.379</td>
<td>300</td>
</tr>
</tbody>
</table>

All shot positions are given simultaneously in geographic co-ordinates (in WGS-94 system) and also in commonly used Króvak's cartesian local system JTSK (Y,X columns). Shooting time and fired charge are also included provided this information is available (the absence of shooting time is not critical, since travel times are present any time in the last table of readings). The first column contains identification of the shot (it may be a number or text). Next table - station/receiver one is similar to the shot table, but it is even simpler:

Example of three lines of the table of stations/receivers:

<table>
<thead>
<tr>
<th>ID</th>
<th>FI</th>
<th>LAMDA</th>
<th>Z</th>
<th>Y</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>21003</td>
<td>50.5987</td>
<td>13.7438</td>
<td>220</td>
<td>782.627</td>
<td>980.010</td>
</tr>
<tr>
<td>21004</td>
<td>50.5659</td>
<td>13.7060</td>
<td>230</td>
<td>785.805</td>
<td>983.234</td>
</tr>
<tr>
<td>21005</td>
<td>50.5497</td>
<td>13.7361</td>
<td>320</td>
<td>783.964</td>
<td>985.324</td>
</tr>
</tbody>
</table>

Again, the first column identifies the station/receiver and co-ordinates are given both in geographical and cartesian systems. Finally, times of propagation are given in the last table:

Example of three lines of the table of readings:

<table>
<thead>
<tr>
<th>Shot_ID</th>
<th>Stat_ID</th>
<th>distance</th>
<th>phase1</th>
<th>phase2</th>
<th>...</th>
<th>phase10</th>
</tr>
</thead>
<tbody>
<tr>
<td>31010</td>
<td>21003</td>
<td>3451</td>
<td>0.947</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>31010</td>
<td>21004</td>
<td>1080</td>
<td>0.608</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
Currently, our table of readings has 10 columns for 10 seismic phases, but it may be made broader in the future. Now we have actual readings of Pg, Sg, Pn, and PmP phases. First two columns in the table of reading are used for identifying corresponding shot and receiver positions. Third column is epicentral distance included for the purposes of fast selection of data.

Content of the Database

Our database contains 17272 readings at the moment. Most of the readings correspond to Pg phase. S waves are present only occasionally, they were picked on three-component recordings from permanent stations of CRNS. Figures 1 – 3 give a simple illustration of the database content.

Possible Areas of the Database Utilization

Fig.4 shows that the best ray coverage is in Western Bohemia, namely in the seismoactive region <12°00'E - 14°00'E> x <49°45'N - 50°30'N> (details in fig.5). This region is known for periodic occurrence of seismic swarms (e.g. Horálek et al. 2000, Fischer and Horálek 2003 and many others, see also http://www.ig.cas.cz/seismo/Webnet/refer.php). Local seismic network 'Webnet‘ consisting of 12 seismic stations continuously monitors the seismic activity in the region. Thousands of earthquakes were recorded and located up to now. The characteristic depth of hypocenters is in the range 6-10 km. It would be an excellent opportunity and a challenge to combine our database and Webnet earthquake catalogue in order to perform full 3D seismic tomography. All previously performed inversions of seismic data were more or less lacking of inappropriate knowledge about the velocity model. Either homogeneous halfspace, or highly simplified 1D gradient or layered velocity models were used.

A simple and instructive way how to use our database is shown in the next example. All Pg phases in the epicentral range 0-120 km were selected and used for interpretation using the „time-term“ method (e.g. Bamford 1977). All static „station“ corrections, all „shot“ corrections and optimum velocity of Pg waves propagation are searched for simultaneously in this approach. The method leads to the solution of underdetermined linear problem, so some regularization needs to be applied. We used the requirement that both „station“ corrections and „shot“ corrections have the same mean value. This supplementary condition is relevant since all shots were fired in places where stations were recording and vice versa. The results are in a good agreement with regional geology (fig.6).

The third example deals with the solution of our grant project GAČR No. 205/03/0999 „The velocity model and shallow geologic building in the Moravo-Silesian region“. During first two years of this project, we succeeded in getting 277 seismic rays covering the area of interest (fig.7a). Our data may be supplemented by archive data from the discussed database. By doing so we got total of 1602 rays (fig7b). The new coverage is definitely denser and there is no doubt that corresponding inversions will be much more stable and reliable.

Conclusions

Our results may be summarized in the following:

- Using data from our database is easy and advantageous
- It is highly recommended to revise the potential of archive data in the stage of planning and before launching new seismic experiments
- It is desirable to complete missing data and upgrade the database
- It is necessary to follow new experiments and to include them into the database whenever possible
- Our database is open to all interested parties via e-mail b.ruzek@ig.cas.cz.
Acknowledgement
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References


joint inversion of quarry blasts, tectonic events and mining induced events. *XXIX-th General Assembly of the European Seismological Commission* (ESC), Potsdam, Germany, 12-17 September 2004. Book of abstracts and papers, p. 119.


Fig. 1 Distribution of times of propagation present in the database according the seismic phase. The column „others“ includes unidentified intracrustal reflections and all S waves.

Fig. 2 Positions of shots.

Fig. 3 Positions of stations/receivers.
**Fig. 4** Available rays

**Fig. 5** Rays crossing the seismoactive area in Western Bohemia
Fig. 6 Time corrections of Pg phases

Fig. 7a (left) 7b (right) Rays in the Moravo-Silesian Region obtained by our own measurements (7a), and all relevant rays including our measurements plus rays from the database (7b)