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New seismic station Pražmo in Silesia and Northeast Moravia, Czech Republic - initial seismological observations

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Analysis of initial seismological observations at the newly established seismic station at Pražmo in Beskydy Mountains is presented in this study. The PRAZ station represents the easternmost station at the territory of the Czech Republic currently and it is supposed that this station will contribute to detection of mining induced events from the Upper Silesian Coal Basin and to local tectonic events in the eastern part of Moravian-Silesian region, where significant seismic source zones of historical earthquakes are located – e.g. Český Těšín and Opava. Seismological recordings obtained at PRAZ station during six months of continual monitoring since December 2018 were analysed not only from the seismological point of view, but the local geology effect has been considered as well. Achieved results proved that the PRAZ station contributes especially to the detection of mining induced events from the Ostrava-Karviná Coal Basin. Evaluation of local site effect by spectral ratio methods, namely the HVNR and the HVSR, confirmed low amplification at an investigated place due to first meters of Quaternary sediments covering the sandstone bedrock. Performed detail analysis of three local tectonic events and one mining-induced event proved that the PRAZ station provides good-quality data for the foci location.

Keywords: *Silesia and Northeast Moravia, seismic monitoring, seismic network, earthquake.*

Introduction

The study presents the first results of initial seismological observations made between the beginning of December 2018 and the end of May 2019 at the newly established seismic station at Pražmo (Beskydy Mountains, Frýdek-Místek district). The Pražmo seismic station (signed as PRAZ) representing the easternmost station in the territory of the Czech Republic is operated by the Institute of Geonics of the CAS (IGN CAS), and it has been established within the frame of the CzechGeo/EPOS-Sci project. The main aim of this station is an expansion of the actual seismic network of the IGN CAS and consequently also local seismic network MONET (MOravia NETwork) operated by the Institute of Physics of the Earth, Masaryk University of Brno (IPE MU). Nowadays, the IGN seismic network consists of the following stations - Ostrava-Krásné Pole (OKC), Stěbořice (STEB), Klokočov (KLOK) and Zlaté Hory (ZLHC). The OKC station is included in the Czech Regional Seismological Network (CRSN), and it is jointly operated by the IGN CAS, the Institute of Geophysics of the CAS (IG CAS) and the VSB-Technical University of Ostrava (VSB-TUO). Stations STEB, KLOK and ZLHC are included into MONET since 2016 for the purpose of the project CzechGeo/EPOS. All stations excepting the OKC have been equipped with the new data acquisition system and seismometer thanks to the financial support of above mentioned CzechGeo/EPOS-Sci project. Interpretation of seismograms carried out by the IGN CAS is focused on picking up Pn, Pg and Sg phases corresponding to local tectonic events, seismic events induced by coal mining in the Czech and Polish mines within the Upper Silesian Coal Basin (USCB), seismic events induced by ore mining in the Legnica-Glogów Copper Belt area (Poland), quarry blasts and other seismic phenomena. Readings are available at the website of the IGN CAS in local bulletins (IGN bulletin, 2019). Data recorded at the OKC and the STEB stations are transmitted online to the data centres at IG CAS and IPE MU, and they are thus available for primary determination of seismic event location. Readings are also included in bulletins of seismic events recorded by the CRSN which are available at the data portal CzechGeo (CzechGeo, 2019). More detailed information about seismic monitoring activities at Silesia and Northeast Moravia, actual and historical seismicity, development of local seismic networks and other studies like, for example, 3D regional velocity model determination are presented in following papers - (Holub et al., 2004; Špaček et al., 2006; Holub et al., 2007; Kaláb et al., 2007; Holub et al., 2009; Holub and Rušajová, 2011; Růžek et al., 2011; Zedník and Pazdírková, 2014; Špaček et al., 2015).

It is assumed that the PRAZ seismic station will contribute to the detection of local tectonic events in the eastern part of Moravian-Silesian region and also to detection of induced seismic events caused by mining activities in the Czech and the Polish part of USCB. The lack of seismic station distribution in the eastern part of the discussed region became evident in the case of mechanism reconstruction of the strongly felt earthquake originated near Hlučín on December 10, 2017, with local magnitude M_L = 3.5 (Hrubcová et al., 2018; Šílený and Zedník, 2018). Authors present class of acceptable and forbidden mechanisms instead of the single best solution due to insufficient density and regularity of nearby seismic stations and they compare the results with the direction of local faults to find related tectonics. The PRAZ station is expected to provide valuable data for

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mechanism reconstruction in such cases of strong local tectonic events. Three seismic source zones are located within the perimeter of 60 km from the PRAZ station where historical earthquakes were documented with the intensity 6 ^{o} MSK and higher - Opava area, Český Těšín area (for example, Schenk et al., 1997) and Žilina area (Slovakia, part of the Pieniny Klippen Belt zone; for example, Kováč et al., 2002). The earthquake near Český Těšín originated on February 27, 1786 (*Io* = 7-8^{o}, *Mw* = 5.44) and belongs to the strongest documented earthquakes in the territory of the Czech Republic within the last centuries. Several historical earthquakes have been documented near Žilina since 17th century – three strongest originated on December 11, 1613 (*Io* = 8^{o}, *Mw* = 5.77), January 15, 1858 (*Io* = 7-8^{o}, *Mw* = 5.44) and October 24, 1858 (*Io* = 6^{o}, *Mw* = 4.46). Next earthquake felt in discussed territory occurred on April 12, 1931, near Opava (*Io* = 6^{o}, *Mw* = 3.9). Epicentral macroseismic intensity *Io* and moment magnitude *Mw* were taken from The SHARE European Earthquake Catalogue (SHEEC**)** 1000-1899 (Stucchi et al., 2013; Locati et al., 2014) and from The SHARE European Earthquake Catalogue (SHEEC**)** 1900-2006 (Grünthal et al., 2013).

Analysed period of six months of monitoring at the PRAZ station provides enough data to perform statistical analysis of recorded events in given categories defined in local bulletins. These results are compared with events recorded at another station located in the territory of Silesia and Northeast Moravia equipped with the same data acquisition system and seismometer – the STEB seismic station. The study also provides brief information about local geology and related site effect investigated using spectral ratio methods, namely the HVNR method for ambient noise records and the HVSR method for records of seismic events. Few examples of recorded seismic events, both the tectonic and mining-induced, originated during the analysed period in the discussed territory are presented including their foci location using data from seismic stations operated by the IGN CAS.

Locality – seismic stations and geology

The situation of current seismic stations operated by the IGN CAS in the territory of Silesia and Northeast Moravia is presented in the Fig. 1 together with temporary stations operated within the CzechGeo/EPOS-Sci project and with the newly established PRAZ station discussed in the paper. Other surrounding seismic stations operated at the territory of the Czech Republic, Slovakia and Poland are also displayed to see how the PRAZ station will contribute to existing national seismic networks at the boundary of these three countries. Seismic stations of IG CAS included in CRSN and stations of IPE MU included in CRSN and MONET are located at the territory of Czech Republic. The National Network of Seismic Stations of Slovakia (NNSS) is operated by the Earth Science Institute of the Slovak Academy of Sciences (ESI SAS), and stations of the Polish Seismological Network (PLSN) are operated by the Institute of Geophysics of Polish Academy of Sciences (IG PAS). Detailed information about all mentioned seismic networks (including local and temporary networks) can be found on the web pages of individual institutions (www.ig.cas.cz; www.ipe.muni.cz; www.igf.edu.pl; www.seismology.sk) and in published papers, for example, Trojanowski et al., 2015; Zedník and Špaček, 2016; Csicsay et al., 2018.

The PRAZ seismic station is installed in a cellar of a small building at a depth of approximately 2 meters below the surface, and its position is defined by geographical coordinates φ = 49.6069^{o} N, λ = 18.4861^{o}E and altitude of 459 m. Local geology represents a layer of Quaternary sediments in the thickness of the first meters covering the sandstone bedrock (for details see Table 1). Local geology can significantly influence the seismic response, and therefore local site effect was evaluated in detail to know possible amplification and the resonant frequency of near-surface layers at the locality. Information about local geology is briefly described in Table 1 also for all permanent stations of the IGN seismic network. The STEB and the KLOK stations are situated in similar conditions as the PRAZ station because all three stations are installed in masonry objects on the surface. Seismometers of the OKC station are installed at a depth of 10 m below the surface directly on the bedrock outcrop in the experimental gallery driven in the weathered slates (Lednická and Rušajová, 2016). The seismic pillar of the ZLHC station is located at a depth of 90 m below the surface in quartzite rock (Zimák and Štelcl, 2000) in restricted underground spaces of speleotherapy that is operated by the private medical institution for children with respiratory diseases – Sanatorium EDEL, Ltd.

The PRAZ station is equipped with the data acquisition system GAIA Q (Vistec company, Prague) and three-component seismometer Lennartz LE3D/5s (Lennartz, Germany) with the frequency range 0.2 – 50 Hz (Fig. 2). The station with a continuous record and GPS synchronization of time operates now in the offline regime. Nevertheless, the data acquisition system enables also on-line data transmission to the centre of the CRSN. Recorded data in MiniSEED format are sampled at 100 Hz frequency, and they are stored on SD card.

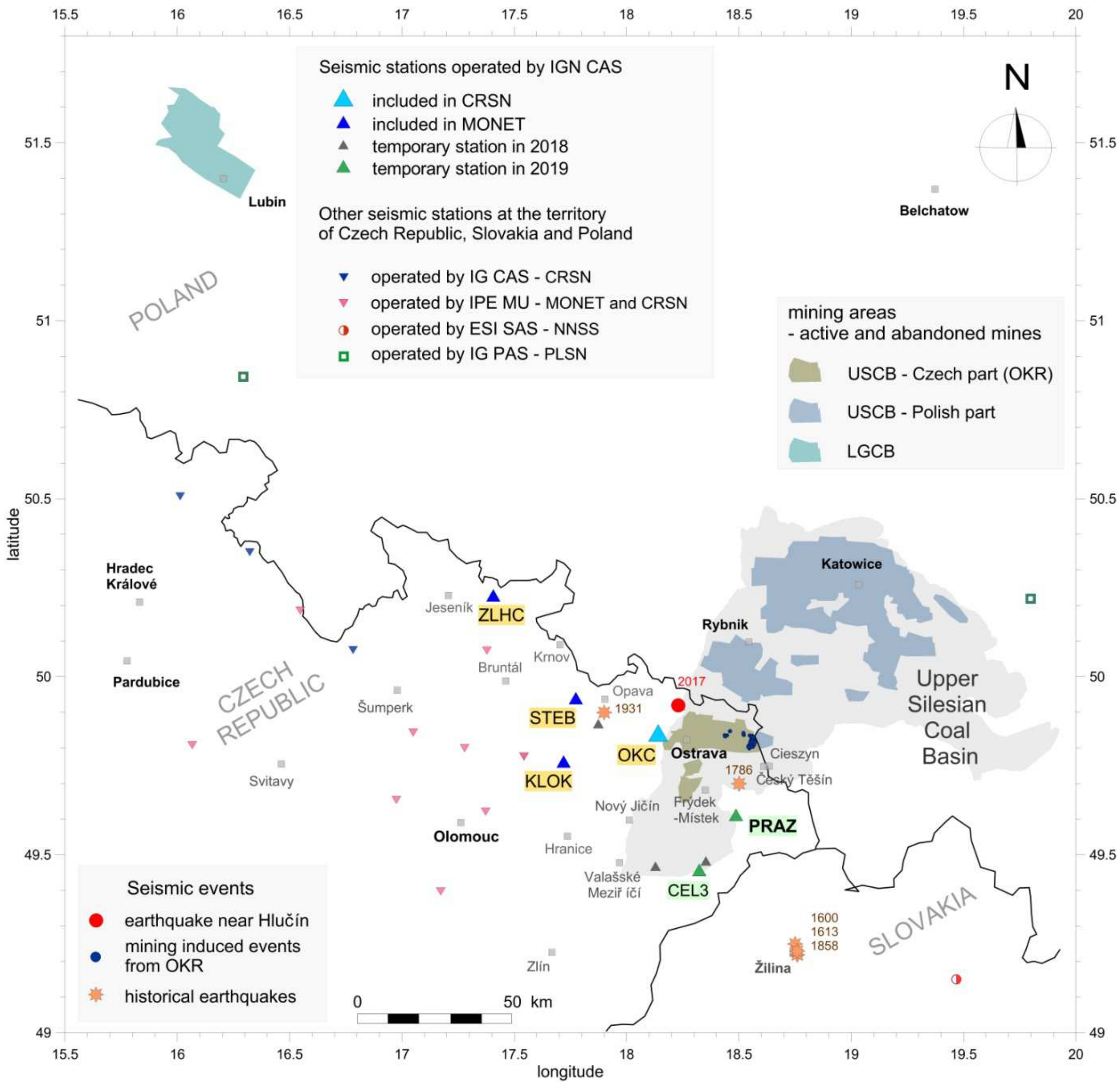

Fig. 1. The situation of seismic stations operated by the IGN CAS in the territory of Silesia and Northeast Moravia in the years 2018 – 2019 and situation of other surrounding seismic stations operated by the IG CAS, IPE MU, ESI SAS and IG PAS at the territory of Czech Republic, Slovakia and Poland. The OKC station is jointly operated by the IGN CAS, IG CAS and VSB-TUO. Temporary station – seismic station tested within the project CzechGeo/EPOS-Sci, CRSN – Czech Regional Seismological Network; MONET – Moravia NETwork, NNSS - National Network of Seismic Stations of Slovakia, PLSN - Polish Seismological Network. Displayed mining areas at the territory of Czech Republic (according to Martinec et al., 2006) and Poland (according Dubiński et al., 2019; Bartlett et al., 2013) represent focal zones of mining-induced seismic events included in the regional bulletins – USCB (Upper Silesian Coal Basin), OKR (Ostrava-Karviná Coalfield), LGCB (Legnica-Glogów Copper Belt). Examples of local seismic events are also presented – historical earthquakes originated near Opava, Český Těšín and Žilina; earthquake originated near Hlučín on December 10, 2017; mining-induced events originated in OKR from December 2018 to May 2019 with released energy more than 1.0E+04 J (GreenGas database, 2019).

*Tab. 1. Brief information about the depth of sediments and type of underlying bedrock at the places of individual seismic stations was compiled based on the Map applications of the Czech Geological Survey. Available boreholes closest to the stations and reaching underlying bedrock were selected from the descriptive database of geological objects (Borehole surveys, 2019). Each borehole is described by the reference ID in the borehole inventory, thickness of Quaternary sediments and type of underlying bedrock. Characterization of Quaternary sediments results from the geological map (Geological map 1:500,000, Quaternary cover 1:500,000, 2019). *Geological map was used for local geology specification directly at the place of KLOK station due to lack of boreholes in the vicinity of the investigated place.*

Station	Borehole ID	Borehole distance from the station	Quaternary sediments	Thickness of QS	Underlying bedrock
PRAZ	487268	326 m	Sandy silts up to silty sands	4.0 m	Sandstone
	487269	345 m	Sandy silts up to silty sands	4.6 m	Sandstone
	487392	201 m	Silty sediments with cobbles	7.5 m	Sandstone
STEB	313120	77 m	Sandy silts up to silty sands	6.0 m	Slates
	313121	22 m	Sandy silts up to silty sands	5.5 m	Slates
	313122	41 m	Sandy silts up to silty sands	8.4 m	Slates
KLOK	317079	927 m	Sandy silts up to silty sands	3.6 m	Slates
	317080	995 m	Sandy silts up to silty sands	2.8 m	Slates
	317082	983 m	Sandy silts up to silty sands	2.6 m	Slates
	Geol. map*	0 m	_	0 m	Slates
OKC	325041	20 m	Clay loam, detritus	4.5 m	Slates
ZLHC	305402	20 m	_	0 m	Quartzite
	305454	20 m	_	0 m	Quartzite

Fig. 2. Apparatus GAIA Q with seismometer Lennartz LE-3D/5s is installed in the cellar of a small masonry building at a depth of approximately 2 meters below the surface.

Used data and methods

Statistical analysis of events recorded at the PRAZ station and comparison with the STEB station

The database of seismic events detected at the PRAZ station was compiled using those events with apparent body wave onsets so that the arrival times of seismic phases Pn, Pg and Sg could be interpreted. All events from this database were compared to events detected at the STEB station that is equipped with the same instrumentation, and that is located in similar conditions – it means masonry object on the surface where underlying bedrock is covered by the first meters of Quaternary sediments. There was no interruption of recording during the analysed period of six months for both stations, so the data are fully acceptable for the analysis. Mutual comparison of the number of detected events was performed for individual categories classified in the bulletins of the IGN CAS:

- **Poland** – mining-induced events from the Polish part of USCB (for example, Stec, 2007); mainly events from the mines near Rybnik and Katowice; epicentral distances usually from 40 to 100 km (PRAZ) and from 35 to 105 km (STEB)
- **OKCB** – mining-induced events from Ostrava-Karviná Coal Basin including destress rock blasting for rockburst control (Koníček et al., 2013; Koníček and Schreiber, 2018); epicentral distances usually from 15 to 25 km (PRAZ) and from 50 to 60 km (STEB)
- **Lubin** – mining-induced events from the mines near Lubin in Legnica-Glogów Copper Belt area in southwestern Poland (for example, Lasocki and Orlecka-Sikora, 2008); epicentral distances from 245 to 275 km (PRAZ) and from 190 to 215 km (STEB)
- **explosions –** quarry blasts from adjacent quarries;

- **tectonic events –** tectonic events at the territory of Silesia and Northeast Moravia (for example, focal zones near Opava, Suchdol, Vítkov and other) and tectonic events from adjacent areas in Poland and Slovakia;
- **other** - for example, events from the open-pits of the brown coal district near Belchatow (Poland), rest of unidentified seismic events, …

Location of events using data from the IGN seismic stations

Several local tectonic events were recorded at the PRAZ seismic station within the analysed period, and three of them were selected for detail analysis of event foci location using only stations of the IGN network – OKC, STEB, KLOK, ZLHC, temporary station CEL3 and discussed station PRAZ. Moreover, one mining-induced event from the OKCB (locality of CSM Mine, released energy 4.13E+05 J; GreenGas database, 2019) has been analysed in the same way using only data from the IGN stations.

Analysis of seismic recordings has been realized using the Seismic Handler software package (Stammler, 1993; http://www.seismic-handler.org/). Foci location computation within Seismic Handler was performed by external program LocSat. Precise manual picking of P and S-wave arrival times is a fundamental part of the computation process. Example of graphical output from the software is presented in Figs. 3 and 4 for the local tectonic event originated near Vítkov on March 27, 2019, and for the mining-induced event originated at CSM Mine on April 15, 2019.

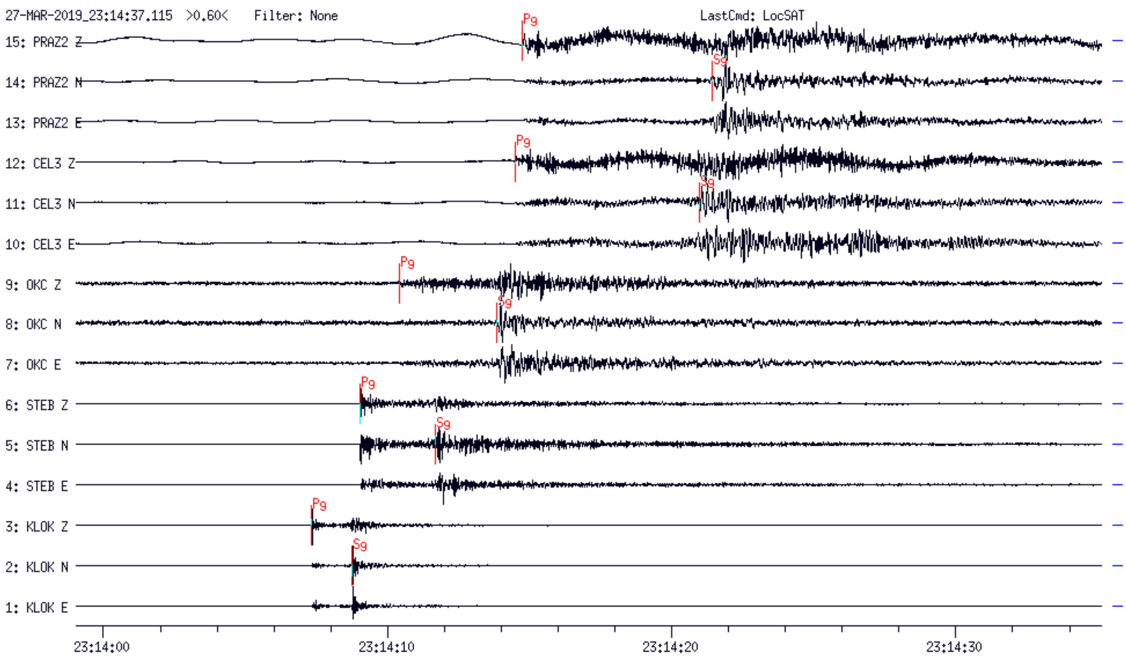

Fig. 3. Graphical output from the Seismic Handler software – manual picking of P and S-wave arrival time; local tectonic event originated near Vítkov on March 27, 2019, with the local magnitude M_L 1.9 (bulletins of seismic events recorded by the CRSN; CzechGeo, 2019).

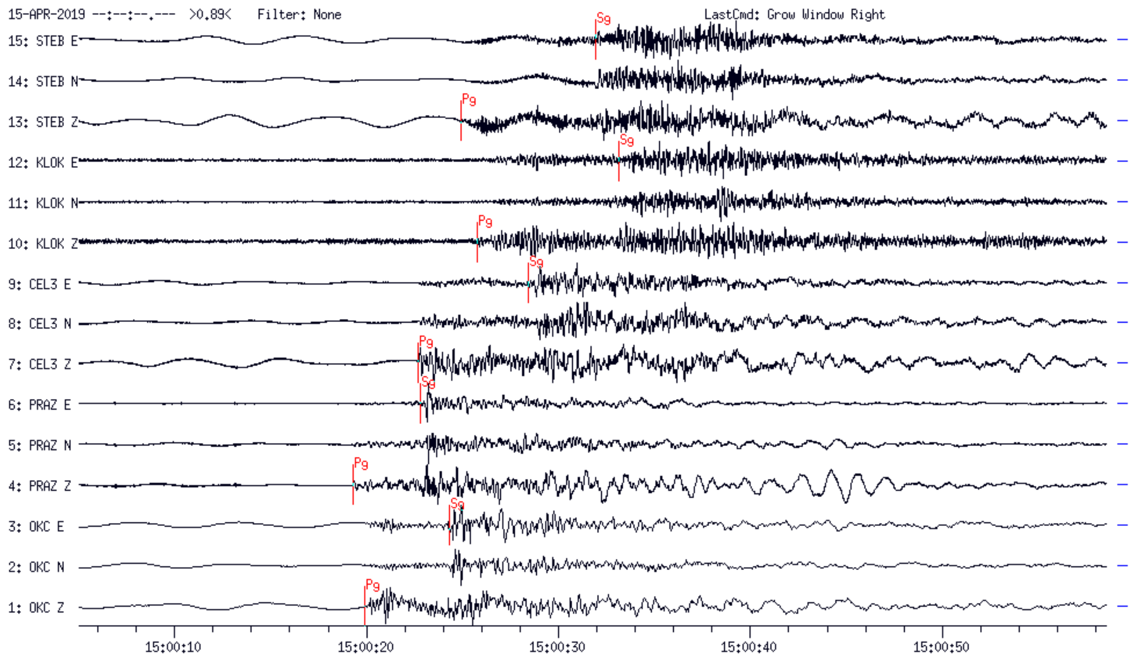

Fig. 4. Graphical output from the Seismic Handler software – manual picking of P and S-wave arrival time; mining-induced event originated at CSM Mine on April 15, 2019, with released energy 4.13E+05 J (GreenGas database, 2019).

Evaluation of local site effect using spectral ratio methods

Local site effect, it means the resonant frequency of sedimentary layers and the amplification factor, was analysed using spectral ratio methods – the HVNR "horizontal to vertical noise ratio method" and the HVSR "horizontal to vertical spectral ratio method" (e.g. Nakamura,1989; Lermo and Chávez-García, 1993). Resonant frequency ***f*** depends on average shear-wave velocity $\boldsymbol{v_s}$ and the thickness of sedimentary layers ***h*,** and it can be described using the following formula:

$$f = v_s\,(4\,h)^{-1} \qquad (1)$$

The amplitude of the fundamental resonant peak depends on the impedance contrast between soil layers and underlying bedrock (for example, Pitilakis, 2004).

Records of the ambient seismic noise were analysed by the HVNR method separately for stations PRAZ, STEB, KLOK, OKC and ZLHC to have the possibility to compare site effect at newly established PRAZ station with permanent IGN stations. The HVNR method uses seismic noise as an input and computes the horizontal to the vertical spectral ratio between the horizontal and vertical components. The data were analysed using the H/V tool of Geopsy software (Wathelet et al., 2011; www.geopsy.org). The duration of selected records of seismic noise measured during the night was approximately 2 hours and more than 100 windows of the length of 60 s were analysed in each record. Before computing the spectral ratio, Fourier spectra amplitudes of individual components were smoothed with the Konno-Ohmachi smoothing function with a smoothing constant equal to 40 and the spectra of two horizontal components were averaged using a quadratic mean. Resulting averaged spectral ratio curve, and its standard deviation was computed for all selected windows.

The HVSR method was applied only for seismic events recorded at the PRAZ station to confirm the results obtained by the HVNR method for this newly investigated locality. Dataset of 14 mining-induced events from OKCB was used for this analysis. The H/V tool of Geopsy software was used for the spectral ratio curve computation again. The length of windows was 40 s, and each window included the part of the seismic record corresponding to S-wave phase, so the total number of selected windows corresponds to the number of elaborated events.

Results and discussion

Statistical analysis and comparison with the STEB station

The number of interpreted events corresponding to individual categories classified in the bulletins of the IGN CAS for the PRAZ and the STEB stations is presented in Fig. 5. The total number of interpreted events per month was from 245 to 375 for the STEB station and from 227 to 334 for the PRAZ station. Mining induced events from the Polish part of USCB represent the substantial part of each data set. Mining induced events from the OKCB represent the second group considering the number of interpreted events.

The STEB station represents the best seismic station of the IGN network for detection of local tectonic events and mining-induced events in the territory of Silesia and Northeast Moravia considering the number of interpreted events in local bulletins (IGN bulletin, 2019). Majority of events from the Polish part of the USCB have a similar epicentral distance to both seismic stations. The lesser number of these events registered at the PRAZ station is related to the higher level of seismic noise at this place, which is approximately by 20 % higher than the noise level at the STEB station. When evaluating mining-induced events from the OKCB, the PRAZ station has detected more events than the STEB station, which corresponds to the location of the PRAZ station, which is much closer to the Ostrava-Karviná Coal Basin than the STEB station.

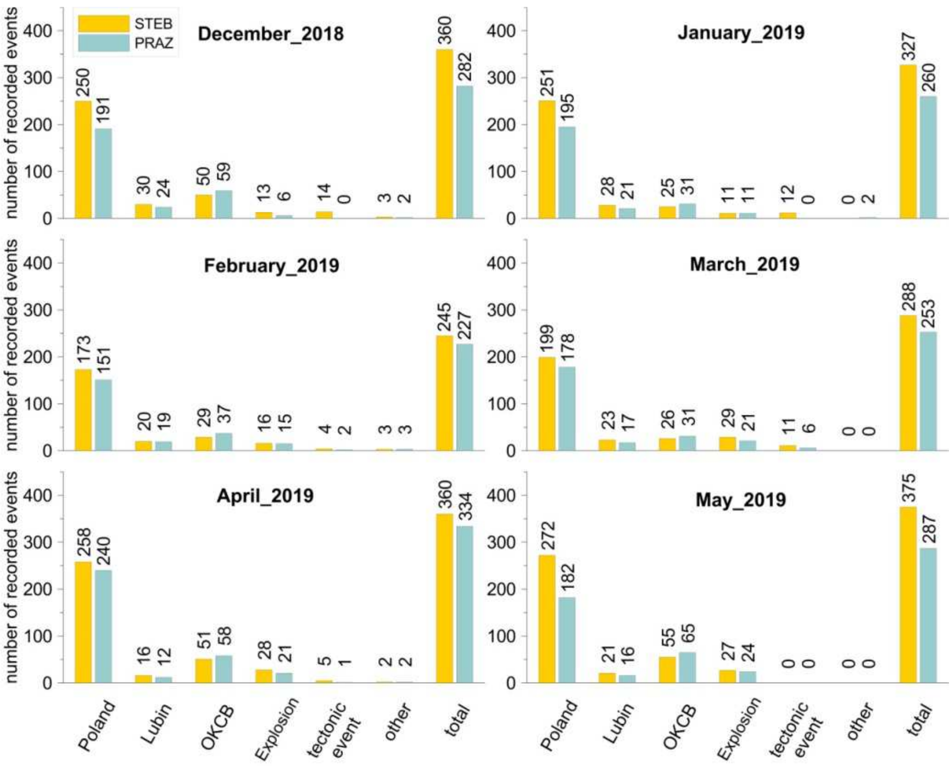

Fig. 5. The number of interpreted events corresponding to individual categories classified in the bulletins of the IGN CAS for the PRAZ and the STEB stations within the period from December 2018 to May 2019.

Location of events using data from the IGN seismic stations

Foci location of four seismic events elaborated by using the Seismic Handler software package is displayed in Fig. 6 – three local tectonics and one mining-induced event from OKCB. Results of foci location computation using LocSat program are summarized in Table 2 for all elaborated events.

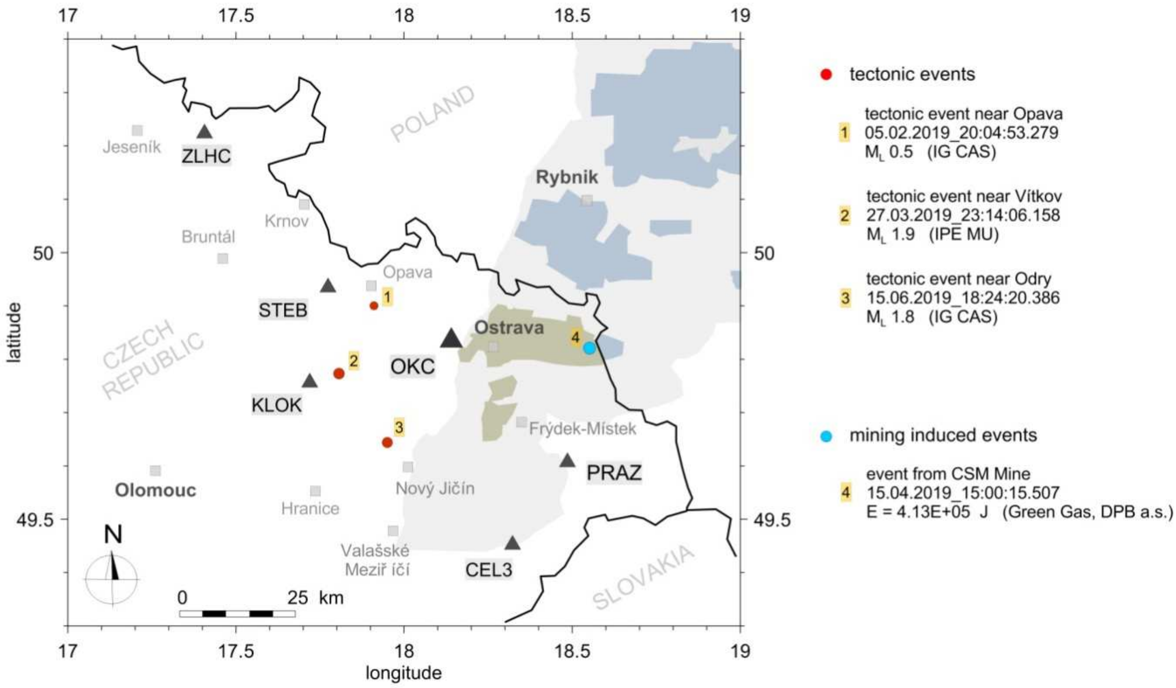

Fig. 6. Foci location of three local tectonic events and one mining-induced event from OKCB. Displayed seismic stations operated by the IGN CAS were used for the foci location computation performed by the Seismic Handler software package.

Tab. 2. Results of foci location computation using LocSat program within Seismic Handler for all elaborated events

Tectonic event near Opava Latitude: 49.900 deg. N		Origin time: 5-FEB-2019_20:04:53.279 Longitude: 17.910 deg. E		Depth: 2.347 km
Station	Phase	Residuals	Distance (deg.)	Azimuth (deg.)
STEB	Pg	-0.1	0.095	291.65
STEB	Sg	0.1	0.094	291.65
OKC	Pg	0.0	0.163	113.54
OKC	Sg	0.0	0.163	113.54
KLOK	Pg	0.0	0.189	220.77
KLOK	Sg	0.0	0.189	220.77
PRAZ	**Pg**	**0.1**	**0.475**	**127.87**
PRAZ	**Sg**	**0.0**	**0.475**	**127.87**

Tectonic event near Vítkov Latitude: 49.773 deg. N		Origin time: 27-MAR-2019_23:14:06.158 Longitude: 17.806 deg. E		Depth: 1.902 km
Station	Phase	Residuals	Distance (deg.)	Azimuth (deg.)
KLOK	Pg	-0.1	0.059	253.52
KLOK	Sg	0.2	0.059	253.52
STEB	Pg	-0.1	0.163	352.57
STEB	Sg	-0.1	0.163	352.57
OKC	Pg	0.2	0.225	73.98
OKC	Sg	0.1	0.225	73.98
CEL3	Pg	0.0	0.465	133.56
CEL3	Sg	-0.3	0.465	133.56
PRAZ	**Pg**	**0.1**	**0.472**	**110.39**
PRAZ	**Sg**	**0.0**	**0.472**	**110.39**

Tectonic event near Odry		Origin time: 15-JUN-2019_18:24:20.386		
Latitude: 49.644 deg. N		Longitude: 17.950 deg. E	Depth: 3.780 km	
Station	Phase	Residuals	Distance (deg.)	Azimuth (deg.)
KLOK	Pg	-0.2	0.219	191.27
KLOK	Sg	0.1	0.219	191.27
OKC	Pg	-0.4	0.267	273.02
OKC	Sg	0.1	0.267	273.02
CEL3	Pg	0.1	0.399	202.03
CEL3	Sg	-0.1	0.399	202.03
STEB	Pg	0.1	0.516	282.98
STEB	Sg	-0.1	0.516	282.98
PRAZ	**Pg**	**0.4**	**0.543**	**263.45**
PRAZ	**Sg**	**0.0**	**0.543**	**263.45**
ZLHC	Pg	-0.1	0.627	337.97
ZLHC	Sg	0.0	0.627	337.97

Mining-induced event from the CSM Mine		Origin time: 15-APR-2019_15:00:15.507		
Latitude: 49.821 deg. N		Longitude: 18.552 deg. E	Depth: 1.765 km	
Station	Phase	Residuals	Distance (deg.)	Azimuth (deg.)
PRAZ	**Pg**	**-0.2**	**0.219**	**191.27**
PRAZ	**Sg**	**0.1**	**0.219**	**191.27**
OKC	Pg	-0.4	0.267	273.02
OKC	Sg	0.1	0.267	273.02
CEL3	Pg	0.1	0.399	202.03
CEL3	Sg	-0.1	0.399	202.03
STEB	Pg	0.1	0.516	282.98
STEB	Sg	-0.1	0.516	282.98
KLOK	Pg	0.4	0.543	263.45
KLOK	Sg	0.0	0.543	263.45

When we compare results of foci location for the mining-induced event using LocSat program with the information listed in the database of GreenGas DPB a.s. (49.831^{o}N; 18.561^{o}E; depth of 986 m; GreenGas database, 2019), the difference in epicentre position is 1.26 km, and the difference in the depth is 0.98 km. The LocSat program used for the computation within the SeismicHandler software uses the simplified velocity model IASP91. This velocity model is sufficient for preliminary computation of the foci location. Nevertheless, it doesn´t correspond to the complex local geological conditions in the Ostrava-Karviná Coal Basin. More precise information about the foci location can be obtained using a representative velocity model determined for given locality (i.e. Kalenda, 1992). In the case of tectonic events originated at the locality of Silesia and Northeast Moravia, more precise location can be obtained by using, for example, 3D velocity model defined by Růžek et al. (2011**).**

Evaluation of local site effect using spectral ratio methods

Resulting spectral ratio curves determined by the HVNR method are presented in Fig. 7 for all investigated stations PRAZ, STEB, KLOK, OKC and ZLHC. Displayed spectral ratio curves show the averaged curve and its standard deviation computed for all selected windows. The flattest shape of the curve with no amplification corresponds to the ZLHC station located in quartzite rock massif 90 meters below the surface. The stations OKC and KLOK show almost flat shape of spectral ratio with amplification lower than 1.5 and no one clear peak. According to Steidl et al. (1996), the existence of weathered rock layers may result in the site effect. According to borehole 325041, which is located almost at the place of the OKC station, there is a layer of weathered slates of the Carboniferous age at a depth of 10 m below the surface where seismometers are installed. The fresh rock is located below the depth of 23 meters (Lednická and Rušajová, 2016). According to the geological map, there are no layers of Quaternary sediments directly at the place of the KLOK station. The station is situated in small masonry object on the surface, so the slight site effect corresponds most probably to the layers of weathered slates near the surface. Remaining two spectral ratio curves exhibit low amplification within the frequency range 2 – 20 Hz for the STEB station and 1.5 – 10 Hz for the PRAZ station. Maximum amplification up to 2.0 falls within the frequency range 5.5 – 7.5 Hz for the STEB and 2.5 - 6.5 Hz for the PRAZ station. The significant peak at frequency 20 Hz on the spectral ratio curve for the PRAZ station do not correspond to the effect of local geology. The amplification is caused most probably by some artificial source of harmonic vibrations in the vicinity of station, because changes of the amplification factor corresponding to 20 Hz are evident on spectral ratio curves calculated for different time periods (Fig. 7) while the amplification below 10 Hz corresponding to site effect is similar for all elaborated curves. In addition, there is not the same peak on the spectral ratio curve calculated for seismic events using the HVSR method presented in Fig. 8. On the other hand, the frequency range of amplification 1.5 – 10 Hz corresponds well to results of the HVNR method. There is only a small difference in the amplification factor close to the frequency of 5 Hz.

Analysis of local site effect proved slight amplification due to Quaternary sediments at Pražmo and Stěbořice locality. Considering the same type of sediments at both localities (sandy silts up to silty sands) with the same values of s-wave velocities, the thickness of sediments at Pražmo locality should be few meters more than at Stěbořice based on obtained resonant frequencies. These results of spectral ratio methods can help to specify local geology, especially at places where there is lack of boreholes and other geological documentation.

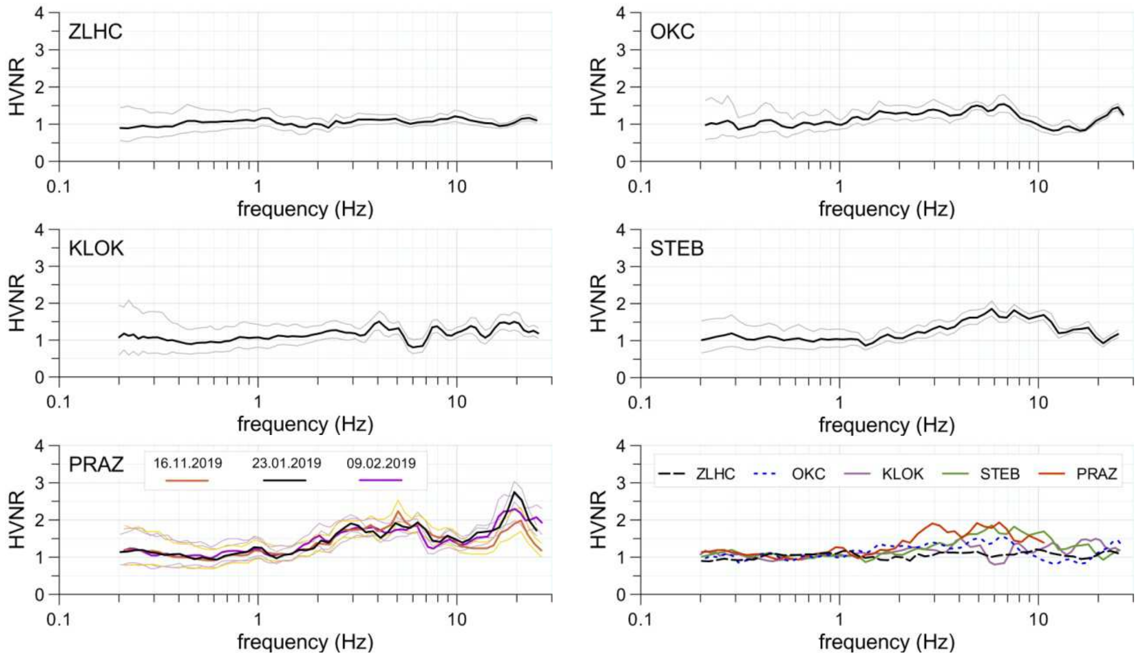

Fig. 7. Spectral ratio curves calculated for stations of the IGN network and for newly established PRAZ station using HVNR method; spectral ratio curves show the averaged curve and its standard deviation computed for all selected windows.

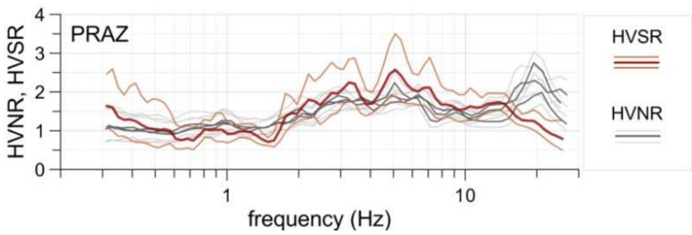

Fig. 8. Spectral ratio curves calculated for the PRAZ station using HVSR and HVNR method; spectral ratio curves show the averaged curve and its standard deviation computed for all selected windows

Conclusion

The main aim of the presented paper was to provide detail information about the newly established seismic station at Pražmo (Silesia and Northeast Moravia, Frýdek-Místek district) representing the easternmost station at the territory of the Czech Republic. Seismological recordings obtained during six months of continual monitoring were analysed not only from the seismological point of view, but the effect of local geology has also been considered. Conclusions resulting from the initial seismological observations at the PRAZ seismic station can be characterized as follows:

- the station has a suitable location for the expansion of the IGN seismic network to the east. Its position near the boundaries between the Czech Republic, Slovakia and Poland will contribute to complement data from Slovak and Polish seismic stations in the case of earthquakes occurring at boundary of these three countries, especially from both regions Český Těšín and Žilina, where macroseismically felt historical earthquakes occurred.
- site effect evaluation by spectral ratio methods confirmed low amplification due to local geology similar to other stations of the IGN seismic network located in similar geological conditions.
- statistical analysis of all interpreted events proved that the PRAZ station contributes especially to the detection of mining induced events from the Ostrava-Karviná Coal Basin.
- nine tectonic events originated at the territory of Silesia, Northeast Moravia and adjacent area in Poland have been detected during the analysed period at the PRAZ seismic station. Performed analysis of selected seismic recordings using the Seismic Handler software package proved that the PRAZ station provides good-quality data for preliminary computation of the foci location.

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