Acta Geodyn. Geomater., Vol. 4, No. 4 (148), 51-57, 2007

SEISMIC ACTIVITY IN WEST BOHEMIA FROM 2001 – 2006

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(*Received* June 2007, *accepted* November 2007)

ABSTRACT
This article is concerned with seismicity in the region of West Bohemia – Vogtland after the Nový Kostel swarm of 2000. Seismicity during the period 2001 – 2006 is weak, though with several clusters of earthquakes; although these do not meet the criteria for a seismic swarm, their grouping in time and spacing along a line give an impression of tectonic disturbances and their behaviour in a period between swarms.

KEYWORDS: seismology, West Bohemia, Vogtland, Nový Kostel, earthquake swarm, microearthquake, en echelon, tectonic line

INTRODUCTION

The Vogtland/West-Bohemia region in the border zone between Germany and the Czech Republic has been known for its seismic activity for several centuries. Seismicity in the area has the character of seismic swarms. At varying intervals swarms of earthquakes arise, the seismicity of which is concentrated in space and time. Other phenomena than seismic activity are also typical for the region: springs and emissions of gases (Kämpf et al., 2007), higher heat flow and the presence of Quaternary volcanic activity (Mid Pleistocenian) (Mrlina et al., 2007). From the turn of the 19th century and throughout the last century, several large swarms were recorded in 1897, 1903, 1908/09, 1929, 1936, 1962, 1985/86 and 2000. The periods between these swarms have lower seismic activity, but even these periods exhibit swarm-like characteristics. Monitoring in the area was carried out by a station in Cheb from 1908 to the 1960s, and from the 1960s seismicity was measured by the first seismic network of the former DDR. Data have been published in a series of papers, e.g. Bormann (Ed.), 1989; Procházková (Ed.), 1987; Horálek et al., 2000 and Nehybka et al., 1994.

MEASUREMENT

The Institute of Physics of the Earth (IPE), Masaryk University in Brno, has maintained its own seismological network, Krasnet, in the area since 1991. The network consists of 5 stations equipped with WDS 2 Hz three component sensors situated in 6 meter boreholes. The Lennartz seismological apparatus amplifies and digitises the signals and simultaneously with the aid of STA/LTA algorithms detects the arrivals of seismic events. The data from all 5 stations, including seismic events, is continuously transmitted to a subcenter. By co-incidence it is determined whether a seismic event has occurred on the whole network and the subcenter selects the section of seismic data to be written on the computer hard-disk. The system of measurement and data collection is explained in detail in: Skácelová and Nehybka, 1995; Nehybka and Skácelová, 1995.

SEISMICITY IN THE AREA

Several thousand earthquakes were registered and localised on the Krasnet network in the period 1991-2006. Seismologists have determined the main areas, in which are the greatest concentrations of earthquake epicentres. On the Czech side these are mainly the area of Nový Kostel – Počátky, further the areas of Kraslice, Slavkovský les and further clusters in the vicinity of Františkovy Lázně, Skalná and Plesná. On the German side they are the areas of Adorf, Bad Brambach, Marktredwitz, Klingenthal and the wider area of Plauen. A detailed description of the seismicity in the region can be found in Horálek et al. (2000), Nehybka (2004), Neunhöfer and Meier (2004). The strongest activity in the period was registered during the seismic swarm from August to December 2000, with the strongest earthquake of a magnitude of 3.2 and a total number of earthquakes within the swarm of more than 10000. More than 3000 earthquakes were localised by the Krasnet network during the period of this swarm (Nehybka et al., 2003; and Nehybka and Tilšarová, 2004). Long term observation has revealed that the majority of events in the region and the majority of energy released are located in the area of Nový Kostel – Počátky. A map of the epicentres in the main epicentral region of Nový Kostel – Počátky is shown in Figure 1. The green and blue triangles mark seismiological stations and red circles mark the epicentres of earthquakes between 1991-2006. It is

clear from the map, that epicentres tend to align along a specific line ("main zone"), which is plotted on the map by a dashed line. The direction of the main zone is 173 degree by Havíř (2002) and 169 degree by Fisher and Horálek (2003).

Seismicity in the area has swarm characteristics. Seismic activity here can be classified by time as well as geographical location criteria. The most significant swarms were detected in the years 1991, 1994, 1997 and the strongest in 2000. (Fischer and Horálek, 2003; Skácelová., 1995; Nehybka et al., 2003) All were in the vicinity of Nový Kostel. Accumulations of seismic activity in other areas were always less significant. In addition to the strong swarm of 2000, there were swarms in 1991, 1994 and 1997 which involved events numbering between hundreds and thousands, with the highest magnitudes being recorded between 2.2 and 2.5. Further, weaker and less numerous activity of events numbering from the dozens to one hundred (known as clusters) were noted in the periods between these smaller swarms. An analysis of these smaller events for the years 1991-1993 has been conducted in Nehybka et al. (1994) and Nehybka et al. (1997). These papers show that the microeartquakes of these clusters do not follow the direction of the main zone as in the case with swarms, but has a tendency to follow a line at a slant from the main direction at an angle of 15 - 30°. Because of the greater degree of seismic activity in the region of Nový Kostel from 1994, these clusters are not at the centre of seismologists' attention.

SEISMICITY 2001-2006

In the present paper we have performed an analysis of these events for the period 2001-2006, in the period after the largest swarm of 2000. The starting point for us were the bulletins of measurements gained from the Krasnet during the period 2001-2006. The criterion for inclusion was the occurrence of at least 20 events over a period of several days or a magnitude for the strongest event in the cluster of greater than 1.0. During the period of 2001 four such swarms occurred. From 25.05 – 28.05 2001 there were 20 events with a maximum magnitude of 1.0, from 2.06 – 15. 6. 2001 70 events with a maximum magnitude of 2.1, from 13.6. – 16.6. 2001 14 events with a maximum magnitude of 1.1 (the last two clusters are concurrent but their epicentres lie at least 7 km apart ; the second of them is divided into 2 sub areas). From 12.7. – 16.7. 2001 there were 26 events with a maximum magnitude of 1.2. The epicentres of the earthquakes from 2001 are shown in figure 2. Activity in 2002 and 2003 was much less significant than in the previous years, and there were just singular events. The period 2004 – 2006 displayed a slow rise in activity, as indicated by the clusters of 22.2.2004 (31 events M_{max}=1.2), 15.6.– 17.6.2005 with 63 events and a maximum magnitude of 0.7 and 21.6.-23.6.2006, 21 earthquakes with M_{max}=0.9.

Figures 2 and 3 show the epicentres of these clusters. It can be seen that the distribution of these individual events does not coincide with the main line of earthquakes seen in Figure 1, but follows a line at a slant of cca 10 – 20° to the east. These directions are in Figs. 2 and 3 marked with the slight lines. This finding is in agreement with the previously published data from the years 1991 – 1993, where there are 5 such clusters at an angle of 15 – 30° to the main line. The structure of the eastern fault and dependent slant with fault splits has already been described in the seismo-tectonic model of west Bohemian swarms of 1985-86 in Grünthal et al., 1990.

CONCLUSIONS

The long-term analysis of seismological bulletins shows that clusters of local microearthquakes which occur in intervals between the major seismic swarm periods can essentially contribute to the study of tectonic setting of the region. Besides the main ranging of earthquakes in the area (Fig. 1) there exists an "en echelon" system of faults (Fig. 2 and 3) oblique to the main line under the angle of 15° to 30°. This article contains the analysis of the 2001-2006 period. The 1991-1993 period was described in Nehybka, 1995 and Nehybka and Skácelová,1997. In the future we intend to conclude the 1994-2000 interval analysis and to join a geological interpretation.

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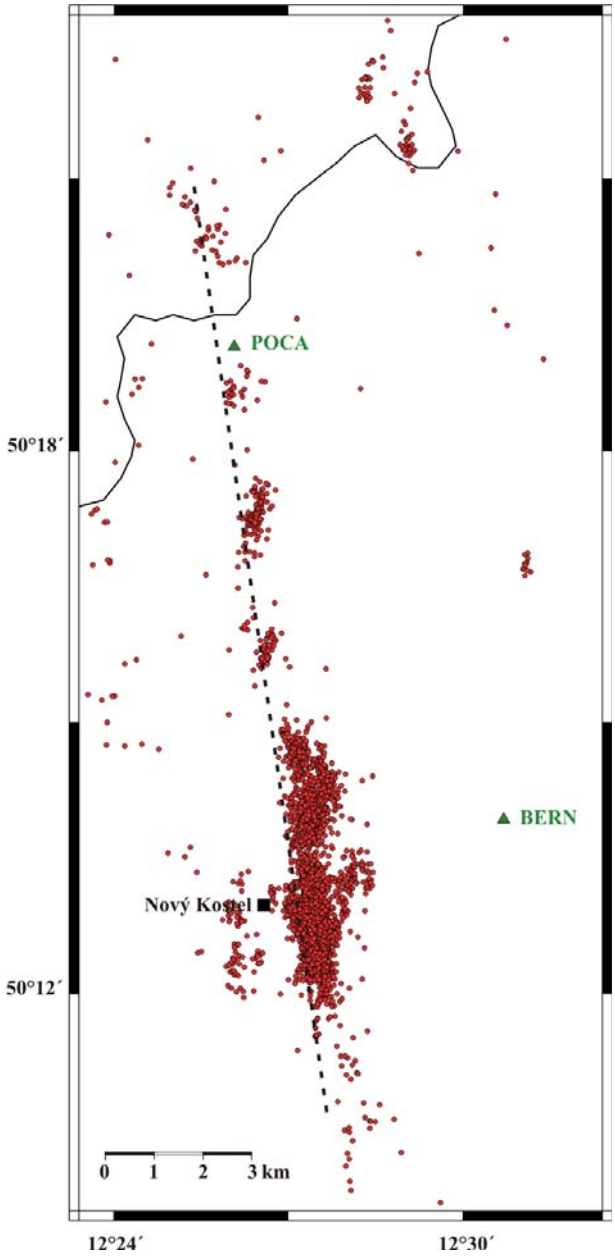

Fig. 1 Map of seismicity in Nový Kostel – Počátky area in years 1991 – 2006 by Krasnet network.

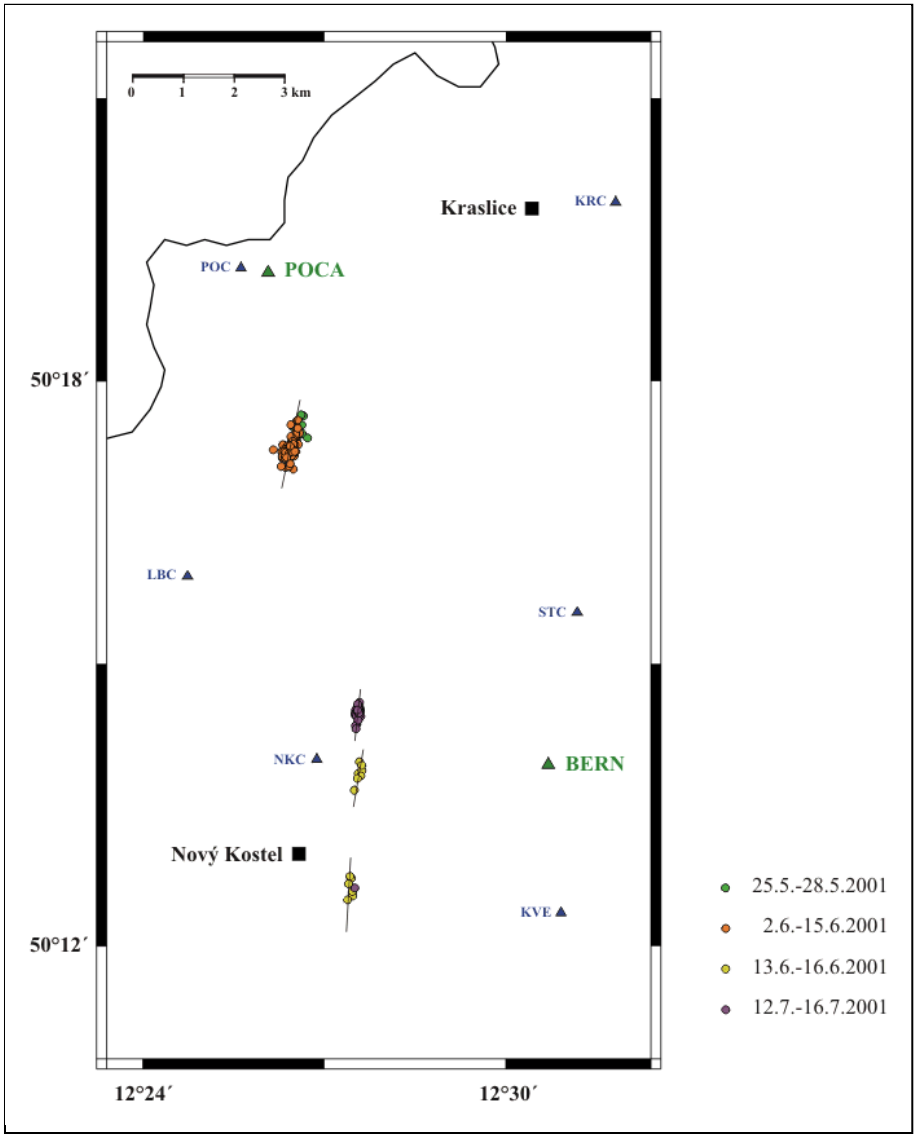

Fig. 2 Seismic clusters 2001 - Krasnet localizations.

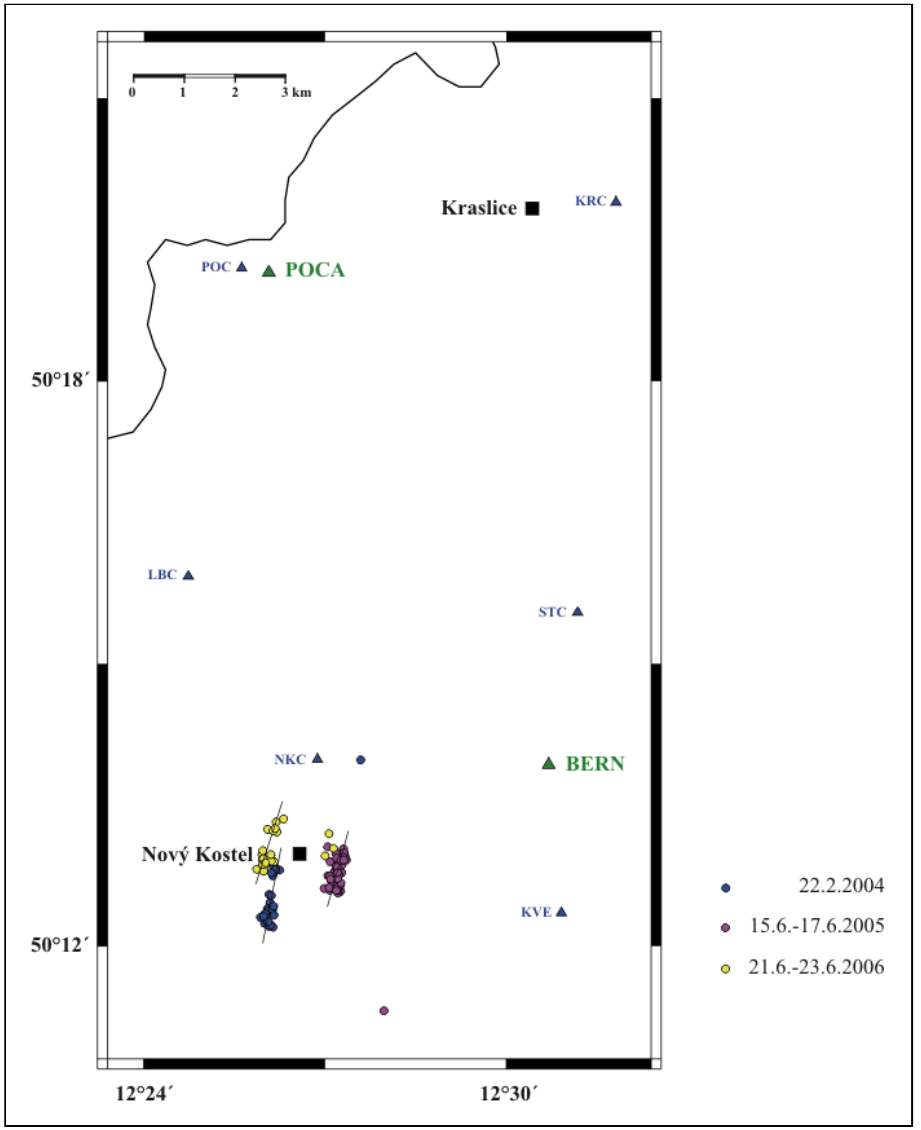

Fig. 3 Seismic clusters 2004 – 2006 -Krasnet localizations.