ROCK MASS RESPONSE TO THE DECLINE IN UNDERGROUND COAL MINING

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Geomechanical problems of mining in the Ostrava-Karviná Coal Basin were studied on the basis of long-term experience gained from seismological observations. They could serve as reasonable models of rock-mass response to temporary reduction and gradual decline in mining activities and mine closure.

Coal and ore mines, induced seismic activity, mining industry, decline

INTRODUCTION

The negative consequences of mining in the Ostrava-Karviná Coal Basin (OKCB) have been the subject of many-years studying. The reasons for the seismic events in mines should be mainly found in stress–strain state changes within the rock mass in deep-level coal mines, but also in open-pit mines. Although the character of these seismic events is very similar to natural earthquakes, their origin is mostly related to the regions of active mining operations in space and time. A lot of seismic events were summarized in a catalogue of earthquakes occurred in the territory of Czechoslovakia [1]. A similar catalogue was compiled for the Polish region [2]. These catalogues are gradually updated on the basis of new macroseismic observations [3], but they are far from being complete, taking into account the present development of natural seismic activity.

It is known that the rockburst occurrence is closely related to the development of coal and ore deposits. The long-term seismological observations proved that mining activities influenced the induced seismicity seriously, though mining is not the only decisive factor. Natural conditions of the deposit, mining technology applied, and the configuration of the deposit sections mined in the past and at present have the great influence on the origin of induced seismic events [4–6]. Both geophysical and geomechanical monitoring of rock mass response to the raw material extraction and/or to its stoppage enables us to observe the variations of stress-strain state in mining areas.

This paper is aimed at presenting several mining and geomechanical situations in coal and ore mines which were observed during the long-term geomechanical practice and which could serve as suitable models representing future rock mass response to the decline in underground mining and/or general stoppage of mining operations.

HISTORY

Mining operations in the region of OKCB started as early as the 19th century when close-to-surface seams were mined. Later the extraction of deeper seams was launched. The synoptical map of mines and mining areas of the Ostrava-Karviná Coal Basin is given in Fig. 1. The first rockburst was recorded in a mine in the eastern part of OKCB, the Karviná partial basin, in 1912. Further rockbursts were observed no sooner than from 1930, mainly in the Ostrava and Petřvald partial coal basins. In the Karviná partial basin, rockbursts were recorded in the 1970s, as exploitation of this partial coal basin was intensified. The rockbursts and induced seismic events, occurred between 1912 and 1990, were initially evaluated in terms of the extent of mine working devastation, later by networks of seismographic stations (Fig. 2).
As for the evaluation of induced seismicity development, before the seismic stations of the local network were put into operation, only macroscopic findings of rockburst effects on mine workings were taken into consideration. The actual position of foci could not be reliably determined from these data exclusively, the more specific time data (day, hour) were also unavailable in many cases. But even this rather subjective evaluation of seismic events gives the idea of the temporal and spatial development of induced seismicity in the course of mining in both the Ostrava-Petřvald and Karviná partial coal basins.

The first surface seismic station in this coal basin was established only in 1977. Its operation confirmed the crucial need of seismology to deal with geomechanical problems, so later seismic monitoring was provided for the rockburst prevention system. In due course the underground stations were launched in other mines. Both local and regional seismographic networks are shown in Fig. 2. During the next 25 years since then seismic equipment (apparatus and software) has passed several important development phases [7, 8].

**SPATIAL DISTRIBUTION OF FOCI OF SEISMIC EVENTS INDUCED BY MINING**

One of the main objectives to establish both the local and regional seismological station networks in OKCB was to obtain information on seismic activity and to determine locations of seismic event foci. At present seismological and seismoacoustic data enable to determine the location of a focus with a specific accuracy (± 100 – 150 m in the horizontal plane and ± 200 m in the vertical plane).

To increase the effectiveness of the local network, mainly with regard to the localization of rockburst foci and the monitoring of seismic regime in the whole area, the current state of individual seismic stations was taken as a basis. The most attention was paid to the development of program tools: from simple to more complicated methods. The results of processing the seismological observations are stored in appropriate databases with the aim of their future use, e.g. to draw partial maps of foci in an area of interest: a whole basin, a mine, a tectonic block, a longwall face and its surroundings, etc. The similar processing method for the location maps may also be employed from the viewpoint of time. The location map can objectively describe both qualitative and quantitative changes in distribution of