MINING SUBSIDENCE FORECASTING BY STRUCTURAL AND GEOMECHANICAL ANALYSIS

LA PRÉVISION DE LA SUBSIDENCE MINIÈRE PAR DES ANALYSES STRUCTURALES ET GÉOMÉCANIQUES

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Abstract
Mining subsidence within Petrila coal field was surveyed since 1978 on several topographic profiles in accordance with the ongoing of the underground works. Availability of a good set of measured data on vertical and horizontal movements of the marks, correlated with detailed knowledge on lithologic and structural conditions provides for a complex modelling approach. Long time measurements are processed by a package of computer programs. Vertical movements, ground tilt and horizontal strain are computed for every year and marked on topographic profiles.

Graphs of the running sums of the subsidence deformations and contour-maps are drawn as main tools for quantitative prognosis. On this experimental basis, subsidence parameters are automatically forecasted for new developments of the underground coal mining during the next five and ten years.

As overlays of the experimental data were tailored numerical models to forecast the evolution of the mining subsidence. The prognosis is validated by analogy with the development of the actual observed subsidence parameters.

Finally, the forecasting package advances definite assessments on building stability risk level induced by the evolution of the ground surface subsidence.

Résumé
La subsidence dans le champ minier de Petrila a été surveillée dès 1978 par des séries de mesures, suite à l'enfoncement des ouvrages miniers. Les valeurs disponibles pour les déplacements verticaux et horizontaux des repères topographiques corréliées avec la connaissance des conditions lithologiques et structurales ont permis l'approche d'une modélisation complexe du phénomène. Les résultats des mesures à long terme ont été programmés sur ordinateur. Les déformations verticales et horizontales et les pendages ont été calculés séparément pour chaque année, et inscrits sur les coupes topographiques.

Les graphiques des sommes cumulées des déformations verticales et les cartes à isolignes de la subsidence ont constitué l'instrument principal de la prévision quantitative. Sur cette base expérimentale, les paramètres de l'affaissement sont automatiquement calculés par l'anticipation du développement des ouvrages miniers dans les prochaines cinq et dix années.

En même temps, les modèles numériques proposés nous ont permis de prévoir l'évolution de l'instabilité minière. La cohérence de la prévision a été vérifiée par le développement des paramètres observés actuellement.

Finalement, les résultats des prévisions sur l'instabilité minière nous ont porté aussi à estimer le niveau de risque de la stabilité des constructions dû à l'évolution de la subsidence.

1. Introduction

The estimation of subsidence of the ground surface induced by deep mining of thick, steeply dipping coal seams is a costly and not very well understood process. The availability of a substantial set of land survey data, over a period of 14 years, within the Petrila coal field offered a suitable opportunity to carry out some simulation models and to check new forecasting procedures.

In the Petrila mining field, within the Petrosani structural basin, the coal seams are located in an Oligocene complex of shales and sandstones, as a monocline dipping 40-80°. The main coal seam, 6-38 m thick, is mined from 400 m downwards by horizontal slicing methods.

2. Processing measured subsidence parameters

Within the mining area, vertical and horizontal subsidence displacements were measured on topographic marks along several profiles orientated perpendicular to the strike of the coal seams.

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Displacements were measured yearly from 1978 to 1991 following the development of mining along the dip of the coal seam.

All topographic data were stored on floppy-disk and processed numerically and graphically by MINDEF program. Surface subsidences were very well documented and drawn (Fig. 1) for each profile and period of measurement.

**Vertical displacements of the ground surface**

The program identifies the value and the position of maximum subsidence as well as the width of the subsidence trough. The maximum subsidence point deviates from the vertical of the middle of mining excavation with an angle almost equal to $90 - \alpha$, if $\alpha$ is the dip angle of the coal seam, disclosing a structural control on the shape of the subsidence trough.

**Surface ground strain and tilt**

From horizontal displacements of the topographic marks the program evaluates the surface ground strain and tilt, subsidence parameters highly significant for the risk induced by subsidence. The MINDEF program identifies the values and locations of the maximum strain due to compression, maximum strain due to extension and maximum ground tilt. Fluctuations of the individual values for ground strains and tilts along each topographic profile and measurement period are quite confusing; but become more meaningful when MINDEF computes and represents their running totals (Fig. 1).