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MINING TREMORS MECHANISMS IN THE WESTERN ZONE OF THE KLODNICA FAULT

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ABSTRACT. The seismic moment tensor inversion method was performed to determine the focal mechanism of mining tremors in the Halemba mine area. This method described previously by [Wiejacz 1991] and [Gibowicz 1992] gives more complete image of the fracture process in the tremor source than the classic fault plain solution. 545 mine tremors were analysed using the SMT software elaborated by [Wiejacz 1994]. The results are presented as the percentage shores of the particular components, showing which type of mechanism is the most important during the fracture process. The obtained results of the seismic moment tensor determination are presented in Figs. 2 – 7.

1. INTRODUCTION

The seismic moment tensor inversion method was performed to determine the focal mechanism of mining tremors in the Halemba mine area, situated in the western edge of Klodnica fault (Upper Silesia Coal Basin – Poland). The research was the last stage of the former investigation performed in the Wujek and Śląsk mine areas presented during the years 1994–1996 [Sagan et al. 1995; Sagan et al. 1996; Dubiel 1996].

545 mine tremors were analysed using the SMT software elaborated by [Wiejacz 1994]. The energy and depth range of the investigated tremors was quite larger than in the previous research. The depth varied from −350 m to −1150 m and the energy range was from $1 \cdot 10^3$ J ($M_L = 0.71$) to $1 \cdot 10^6$ J ($M_L = 2.54$). The method described previously by [Wiejacz 1991] and [Gibowicz 1992] gives more complete image of the fracture process in the tremor source than the classic fault plane solution. The decomposition of the seismic moment tensor presents the focal mechanism as a result of three fracture processes:

- volumetric changes represented by the isotropic component of the seismic moment tensor;
- uniaxial compression (or tension) represented by the CLVD component (compensated linear vector dipole);
- shear failure represented by the DC component.

The results are presented as the percentage shares of the particular components, showing which type of mechanism is the most important during the fracture process. The additional information can be obtained by the spatial orientation of the fault planes from the DC component.

The Halemba mine is situated in the western edge of the Klodnica fault and closely to the folded region of the western USCB area. The geological structure is similar to the Wujek and Śląsk mine areas, because it is situated in the same geological structure – the Main anticline. Coal seams have the weak dip to south (5–12°). The Klodnica fault (amplitude 100–300 m) forms the southern boundary of mine area.

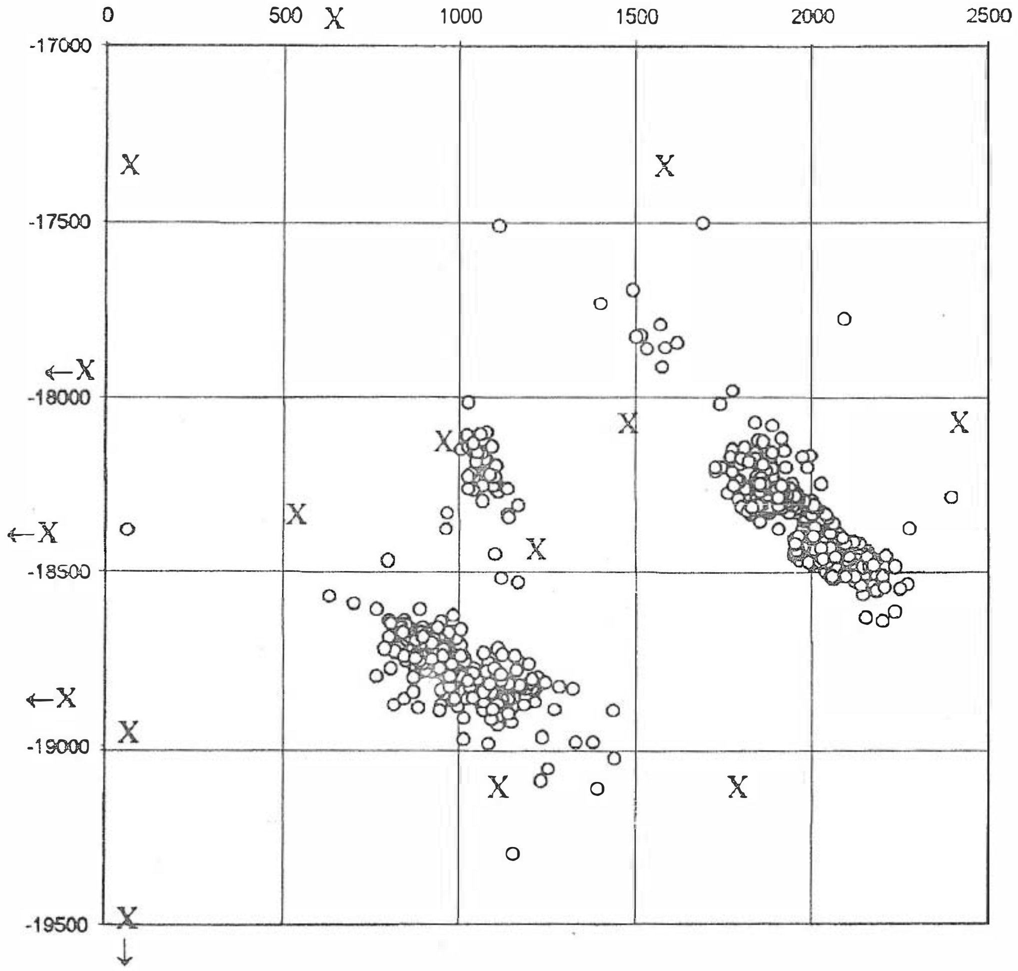


FIG 1. The horizontal distribution of the investigated tremors with seismometer positions.
X – seismometer site
o – locations of tremor's source

The investigated tremors group into three regions according to the performed mining activity in 1995. The horizontal distribution of the tremors foci is presented in Fig. 1. These regions were situated relatively well in relation to the existing seismic network, much better than the tremors from the previous research. The number of the seismometers was also larger (16 stations). The results obtained with such a large number of the seismometers should be more reliable than in the Wujek (12 stations) or Śląsk (8 stations) mine areas. The number of stations is the maximum available number of entries, in some cases the smaller number of the stations had to be used for the calculations.

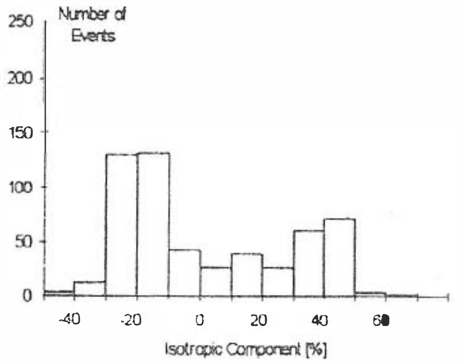


FIG 2. The percentage share of the isotropic component (+ means explosion, – means implosion)

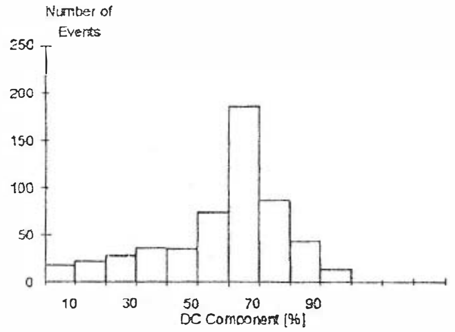


FIG. 3. The percentage share of DC component

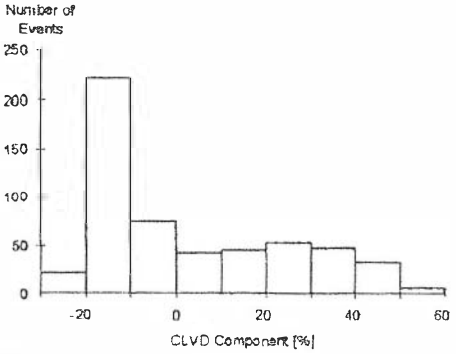


FIG 4. The percentage share of CLVD component. (+ means tension, – means compression)

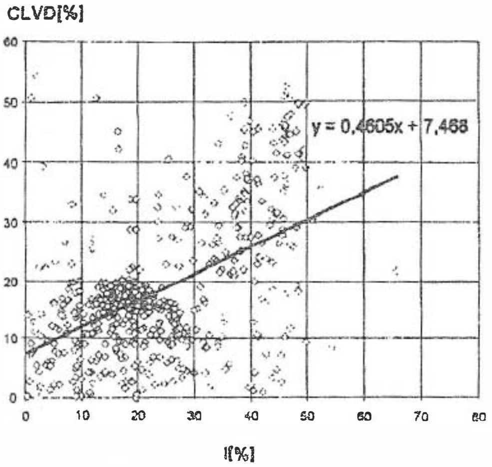


FIG. 5. CLVD versus isotropic component plot

2. THE OBTAINED RESULTS

The obtained results of the seismic moment tensor determination are presented in Figs. 2–7. Figures 2, 3 and 4 shows the percentage shares of the particular compo-

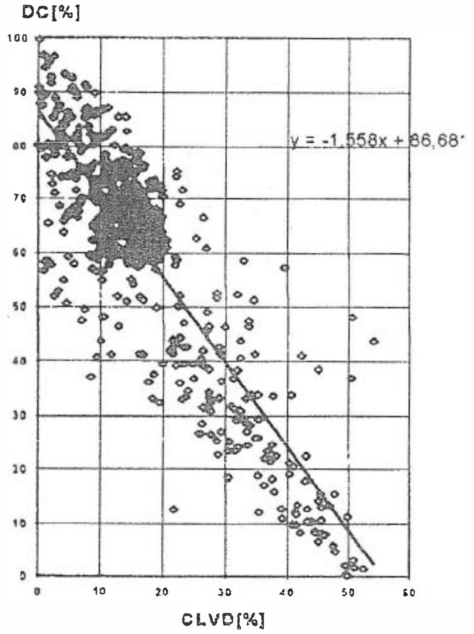


FIG. 6. DC versus CLVD component plot.

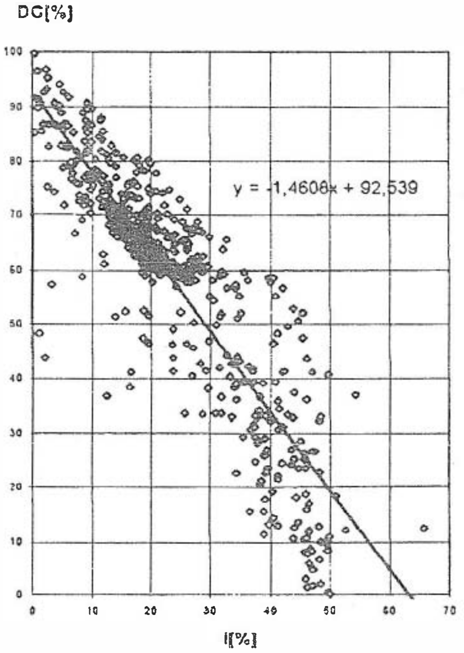


FIG. 7. DC versus isotropic component plot

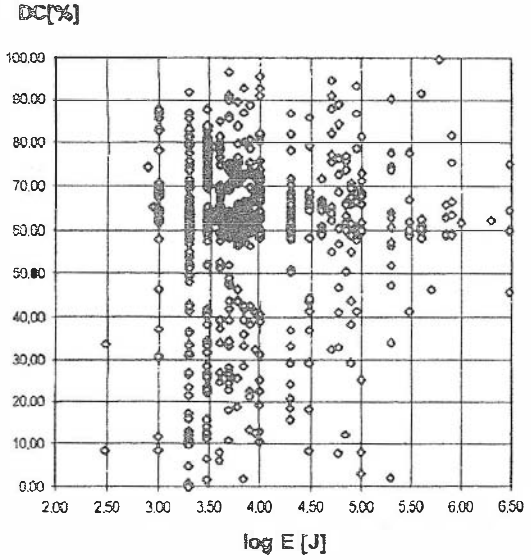


FIG 8. Relation between DC component share and the energy of the events

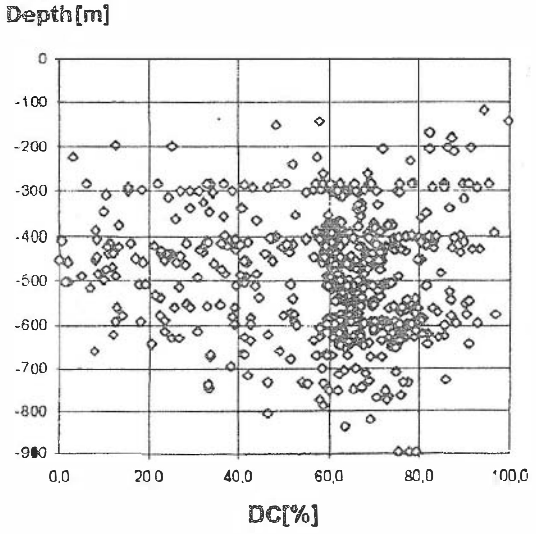
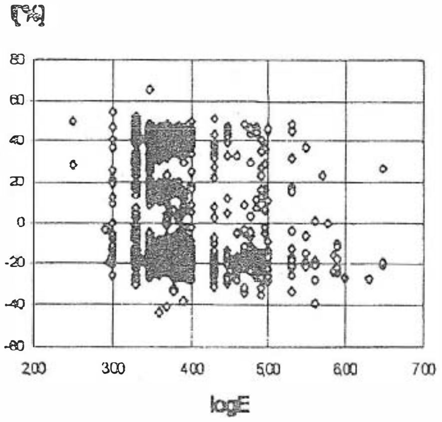


FIG. 9. Relation between DC component share and the depth of the events

nents. The isotropic component plot (Fig 2.) shows some kind of bimodal character with maximum shares for about −20 % and +40 − 50 %. According to this plot and



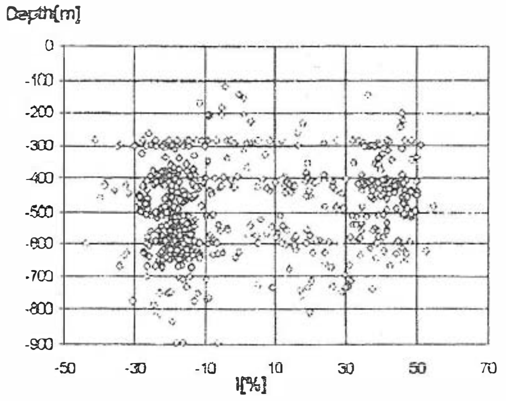
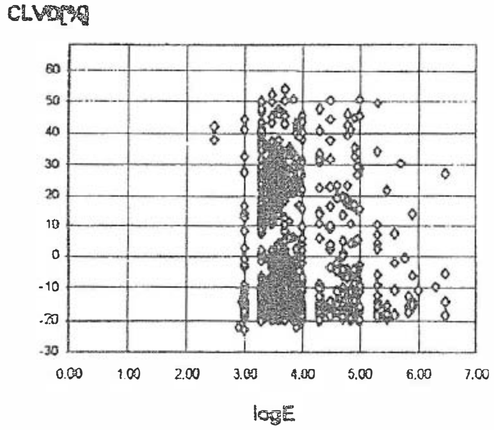


Fig. 10. Relation between *I* component share and the energy of the events

Fig. 11. Relation between *I* component share and the depth of the events



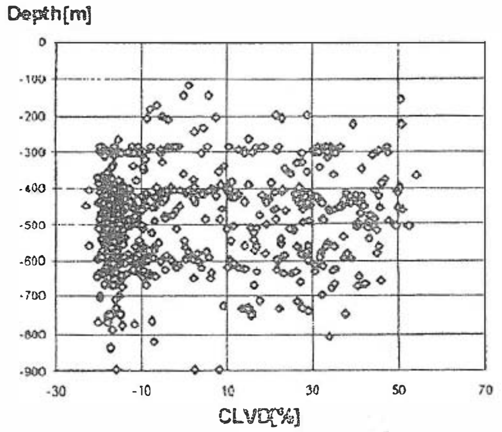


Fig 12. Relation between CLVD component

Fig. 13. Relation between CLVD component share and the energy of the events

to the previous results two types of the mining tremors can be distinguished: the first one with relatively big share of isotropic component corresponding with weak DC component share, and the second one with dominant DC components. This two types of events are also visible in Figs. 7, where two dotted areas can be observed. The first dotted area (on the negative range of both variables) corresponds with dominant DC component share. The second one (on the positive range) is less visible due to the various value of the CLVD component.

The unimodal distribution of the DC component share (Fig. 3) is similar to the previous research [Dubiel 1996; Gibowicz 1996; Sagan et al. 1996]. The second maximum suggested in the other mining areas disappears on the DC component plot for the Halemba mine area.

The CLVD distribution plot (Fig. 4) is also unimodal with maximum between

$-10 - 20\,\%$, which corresponds with DC maximum (60–70 %) and I component maximum ($-20 - -10\,\%$).

The plots of the relationships between show the high correlation between the particular components of the seismic moment tensor and emphasize the general distribution of the obtained types of mechanisms. Of course such relationships are mathematically. The results are very similar to the presented ones previously [Gibowicz 1996], the correlation coefficients seem to be the best for DC versus I plot and DC versus CLVD plot. The relationship between I and CLVD components is much worse.

A big number of the investigated events and a significant depth and energy differentiation gave the opportunity to make the plots of the relationship among energy (magnitude), depth, and particular components of seismic moment tensor. On the Figs. 8 and 9 the relationships between DC and depth (or energy) are presented. For the small events ($\log(E) < 5$) the random distribution of the DC share is observed. For the stronger tremors there is no solutions with low DC share, all events have DC share close to 60–70 % interval. According to the presented plots the pure shear seems to be the dominant failure mechanism for the strong events. It is consistent with the previous papers on the bimodal character of the mining induced seismicity, e.g. [Kijko et al. 1987; Idziak et al. 1991], where the strongest events were assumed to be weakly related to the mining activity, but closer related to the regional stress disturbances.

The above mentioned relationships are less visible on the next plots (Figs 10 and 11), presenting the isotropic component share as a function of the depth or the energy.The similar situation can be observed in the next two plots (Figs 12 and 13) with CLVD component shares.

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