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ANOMALOUS DRILL-CORE PARTING IN THE SEDIMENTS OF THE UPPER SILESIAN BASIN

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Abstract: Anomalous jointing of drillcores is sometimes observed in prospect boreholes in the Upper Silesian basin. The drillcore is jointed into discs, slices or porringers that are not resemblant to natural jointing. This occurs in various types of sediments, but especially in brittle rocks. Orientation of jointing planes is perpendicular to the borehole axis and does not depend on the distance from the front of the core run. Anomalous jointing reflects locally increased stress in the layer.

Key words: core, anomalous parting, state of stress.

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INTRODUCTION

The Freiberg method (Thoma, 1964) is one of the methods used in the prognostics of rock-burst and gas-burst occurrences. It employs anomalous parting of drillcores into bowls, discs, plates or rollers (further referred to as discs). Anomalous parting has been observed in mines in Russia, Germany, and Poland in connection with bursts of sandstones, salts, and gases. Great attention has been given to the study of this phenomenon in the mines of Donbas (Zabigailo *et al.*, 1974).

According to the findings of Zabigailo *et al.* (1974), separation of rock into discs is an indicator of rock potential for failure, but the author himself admits a limited applicability of this method. Formation of discs during drilling depends on the state of stress of the massif, and the strength and strain characteristics of rocks. According to the above author, parting of a drillcore from the massif is more probable in brittle rocks. Separation into discs may occur in the event of a certain combination of these properties. The dependence between the incidence of disc formation and the petrographic composition of sandstones found in the Donbas area, however, cannot be applied to the Upper Silesian Basin (USB). This fact is probably caused by higher diagenetic lithification of the sandstones near Ostrava, with partial elimination of the effect of individual rock constituents.

MATERIAL AND METHOD

Anomalous drillcore parting has been studied in boreholes drilled from the surface, as well as in mine boreholes in the USB for the last 15–20 years. Intervals of anomalous parting have been observed in beds of sandstone, conglomerate, and coal (Fig. 1). In boreholes drilled from the surface, these effects were clearly identified in one case during the above-mentioned period. A more common phenomenon was tapering of the drillcore into a steep cone, mostly on 20 cm segments of sandstone, sometimes even at both their ends. Consultation with drilling technologists did not exclude a possibility of core-breaker involvement in this phenomenon. At a depth of 1,322 m of borehole NP 820, a sandstone segment with such a type of ending was disintegrated into a series of cones inserted into one another (Fig. 2F); moreover, occurrence of bowl-shaped parting was registered in the proximity of this find. These effects are more frequently observed in drillcores derived from subsurface drilling, probably due to a smaller core diameter; hence, also a smaller strength necessary for the disk separation. Finds of anomalous parting were recorded in a database with ca. 230 cases registered to-date. The database also includes finds from boreholes in Poland (e.g., Jaworzno 6757 d), and samples from a skip pit at Slaný. Many examples were, however, observed at joint core inspections attended by the staff of the Ostrava–Karviná Mines, and not included in the database.

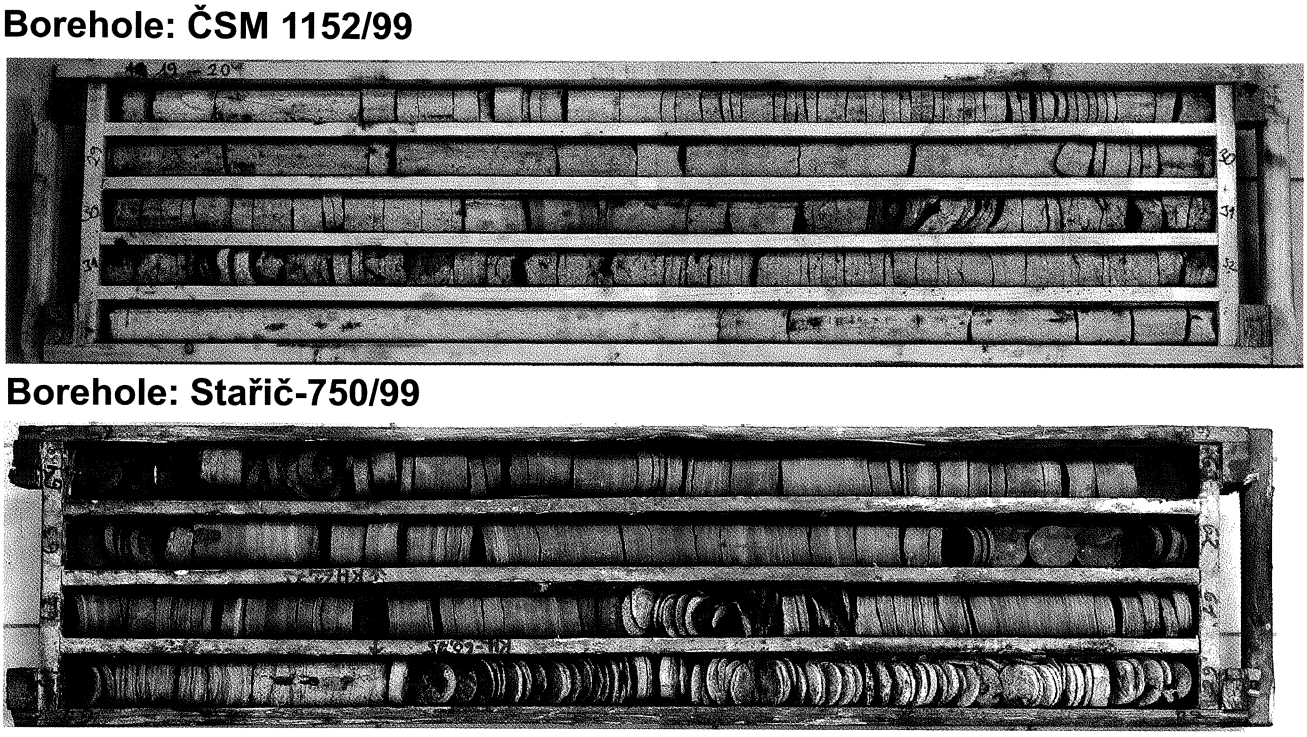

Fig. 1. Intervals of anomalous drillcore parting in boreholes ČSM 1152 and Staříč II - 750

DISCUSSION

The following facts were ascertained based on the analysis of individual finds:

1. The effects of anomalous drillcore parting include (Fig. 2): a) plates, b) discs, c) bowls, d) rollers, e) predisposition, f) a series of cones inserted into one another.

2. Intervals of anomalous drillcore parting are several centimetres to several metres thick. Disc thickness may vary even in a single interval, and discs may be combined with rollers.

3. The described anomalous parting is different from natural disintegration of sediments, which is controlled primarily by their bedding. Thin sections orientated perpendicular to bedding show accumulations of mica, coal matter and other inhomogeneities on the bedding planes. This disintegration is typical especially for claystones, siltstones or laminated sandstones with tabular bedding, which were not included in this study.

Anomalous parting originates in the course of drilling, regardless of the orientation of the borehole relative to the bed. Axes of bowls or other types of anomalous parting are always parallel to the borehole axis. The cores sometimes show only indications of this phenomenon, characterized by circular fractures on the circumference of the core, also orientated perpendicular to the borehole axis. These discontinuities (this is the term we use for these hair-thin fractures for simplicity) were studied in thin sections of perpendicular orientation (Fialová & KoŽušníková, 1986). They have the form of parallel fractures dilated to 0.04 mm, accompanied by a zone 1.29 mm thick of a network of minute discontinuous fractures (Fig. 3A). The rest of area of the thin section otherwise is featured quartz grains with fractures of various orientations.

Discontinuities have both intra- and intergranular course, sometimes with tooth-like parting of quartz grains (Fig. 3B). These fractures do not result from accumulation of minerals of lower strength at the site of the discontinuity. It can be presumed that in such cases the stress in the bed was too low, or the strength of the rock was so high that the plates did not separate completely. These cases are commonly observed in conglomerates or in some types of sandstone.

4. It can be inferred from the available finds that the formation of discs is not restricted exclusively to thick sandstone complexes or to a particular position within these complexes (the base, the top etc.). Anomalous parting can equally be observed in all Carboniferous strata in the USB, and it is independent of the distance from the borehole collar. Higher frequency was, however, encountered at stratigraphic levels that bear sandstone beds confined to a particular stratigraphic interval (e.g., the Saddle Member, Lower Petřkovice Member).

5. Several intervals with anomalous parting were sometimes encountered in a single sandstone complex (max. 6 intervals in borehole Staříč 770). In some cases, the first drilled interval has the highest thickness and the last drilled interval has the lowest thickness (gradual stress release in the bed?).

6. Four boreholes drilled from the bottom of a shaft were inspected at the Frenštát Mine; one of them is vertical whereas the others are inclined by up to 40° from the vertical. Discs in all boreholes are orientated perpendicular to the core axis. In the siltstone succession with two quartzite

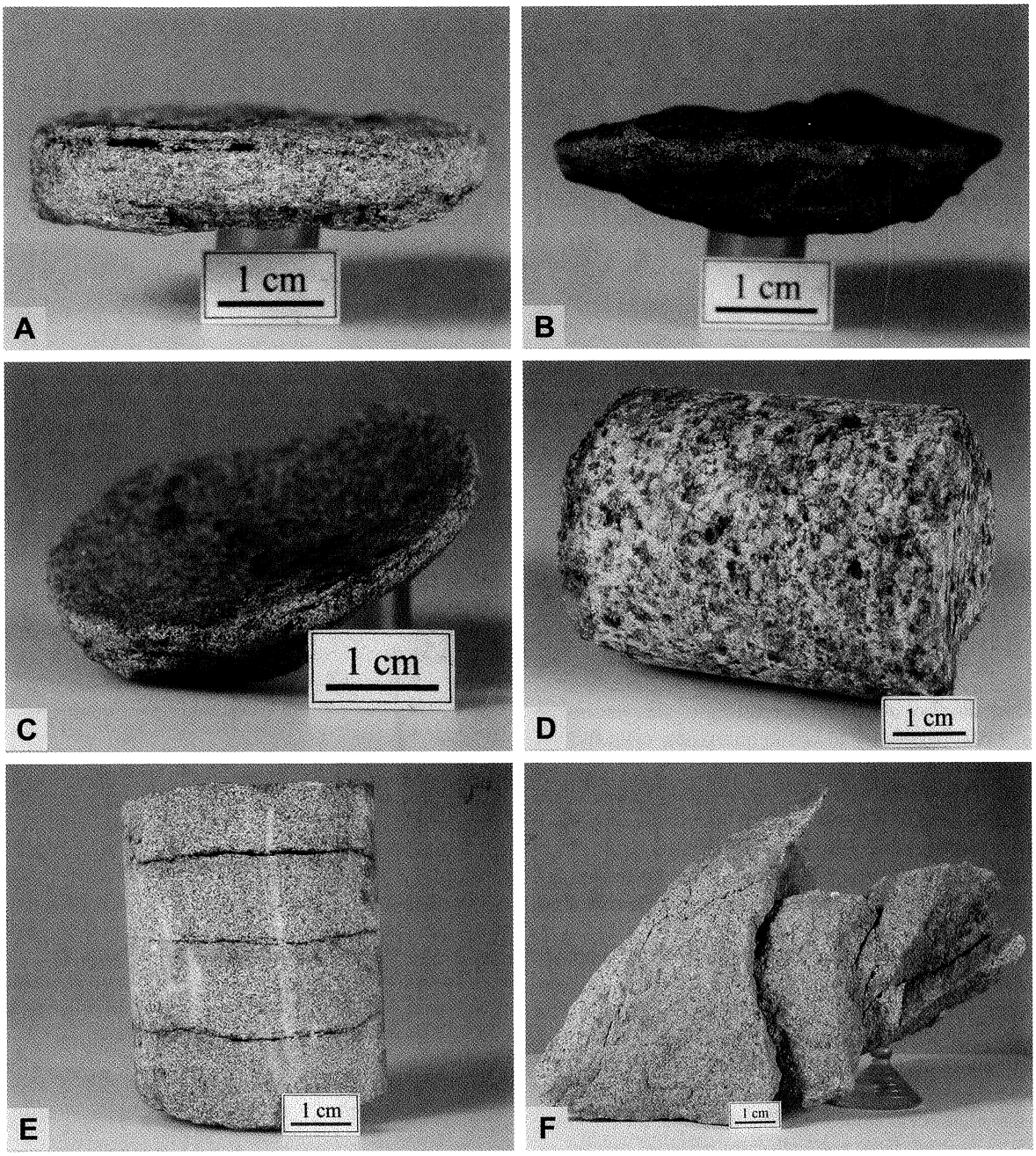

Fig. 2. Types of anomalous drillcore parting: **A.** plates; **B.** discs; **C.** bowls; **D.** rollers; **E.** predisposition; **F.** a series of cones

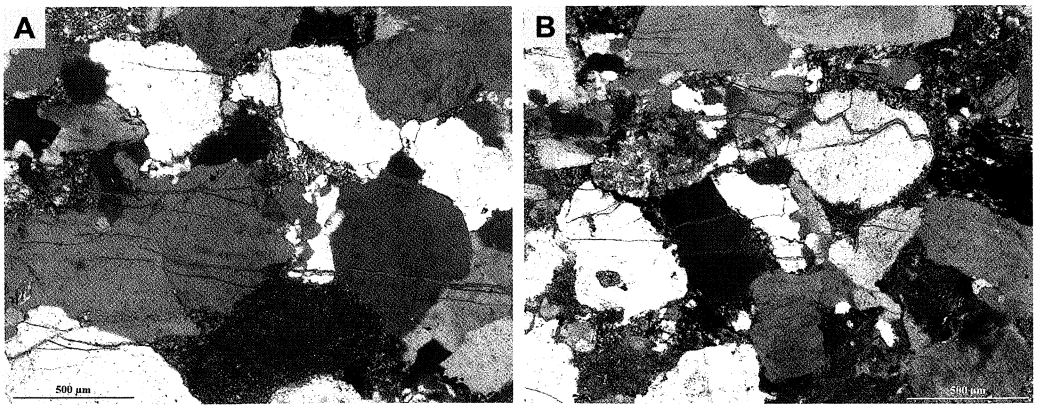

Fig. 3. The zone of fracturing, transmitted light, crossed nicols: **A.** parallel fractures; **B.** tooth-like fracture of quartz grains

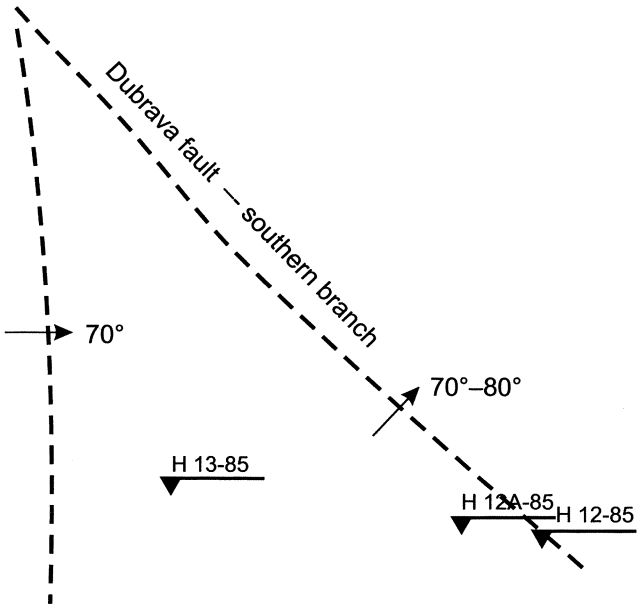

Fig. 4. Location of boreholes with the occurrence of discs (ČSA Mine, block 8)

beds below the Prokop Seam, interestingly, the occurrence of discs is restricted only to brittle quartzites, even though the same drilling technique was employed.

7. Most boreholes with the occurrence of anomalous parting are situated in the proximity of faults (max. 100–150 m), most typically normal faults (Fig. 4).

8. Intervals with anomalous parting in boreholes located close to each other generally occur at the same stratigraphic level (H 13, H 12 and H 12 A).

9. A mathematical model was formulated (Malík *et al.*, 1990) to explain the origin of disc-shaped parting, presumably resulting from stress in the bed or in the massif. The power thrust effect of the core bit on the rock and the dynamic effects of drilling were neglected for simplicity. If these factors were of decisive importance, parting would appear in the same rocks at any depths, which is not the case. Parting was proved to be controlled by material properties and the stress tensor, which characterizes the original rock massif and changes upon drilling.

10. Anomalous parting is present in brittle rocks, in sandstone and coal beds, less frequently in conglomerates. Its occurrence is, however, not controlled by the proportions of matrix and other rock constituents, provided that the latter do not alter rock brittleness. Rocks with the most frequent occurrence of discs mostly show brittleness coefficient (uniaxial compression strength vs. tensile strength ratio) higher than 10.

11. No direct correlation was found between disc occurrence and position in the borehole by comparing records in the drill record (depths of core runs) and disc occurrence (Fig. 5).

CONCLUSION

As indicated by the data obtained, anomalous drillcore parting is a significant geomechanical criterion of primary stress state of the rock massif. As such, it should be consistently followed and recorded. The data suggest that the disc occurrence alone cannot be used for rock-burst prognostics directly, but indicates locally increased stress in the massif. Thus, it indicates a situation in which rock-burst may be expected with a certain probability, due to the combination of natural and technological conditions.

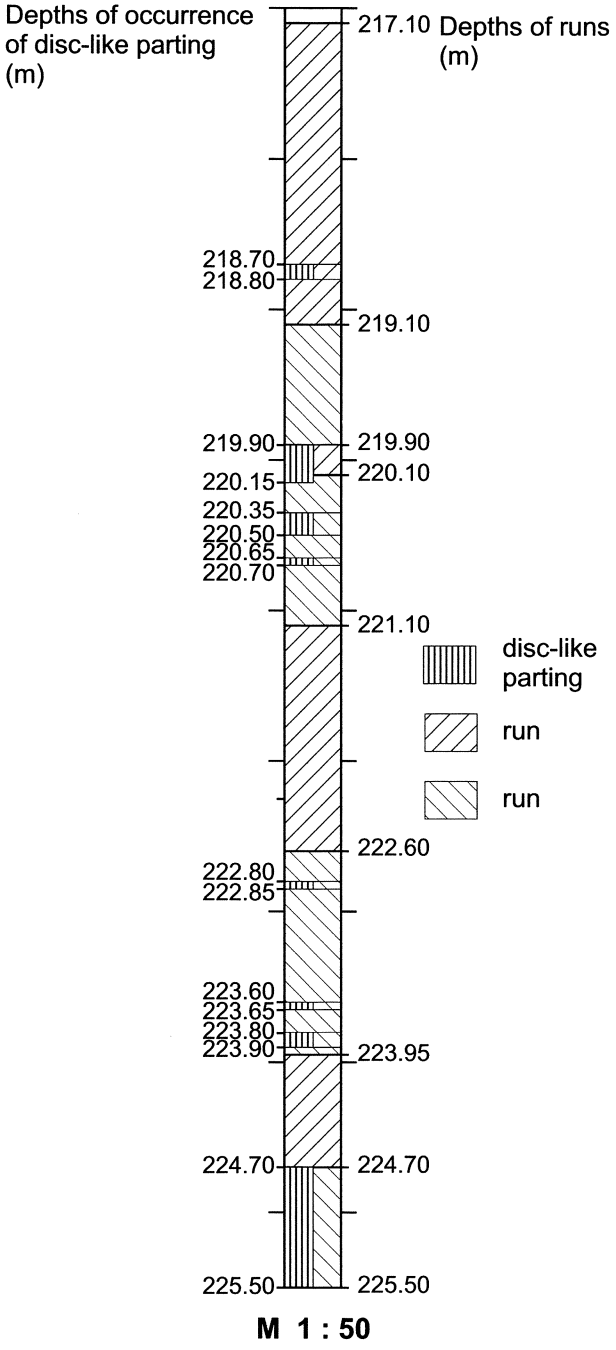

Fig. 5. Intervals of anomalous parting occurrence vs. core runs

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