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THE MŠENO–ROUDNICE BASIN: PROBLEMS OF RECONSTRUCTION OF FOSSIL STREAM PATTERN (CENTRAL BOHEMIAN COAL BASINS, CZECH REPUBLIC)

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Abstract. The Mšeno–Roudnice Coal Basin is an eastern part of the Central Bohemian Carboniferous Coal Basins. The total thickness of the Carboniferous sediments is ranging from several tens of metres in the south up to nearly 1 km in the basin centre. The basin was explored by nearly 55 deep boreholes with the aim to explore coal reserves. The seismic exploration in the basin has been carried out, too.
Fossil stream pattern was reconstructed, of which rivers eroded the upper part of the Slaný Formation sediments during the intra-Stephanian hiatus between the Slaný and Líně Formation (Stephanian B/C). The project could have been realized due to some drilling close to seismic profiles, and also at least due to locally favourable seismological conditions. The results allowed to decipher the anomalous depositional structure of the Slaný and Líně formations that was difficult to be defined earlier. The results showed that some tectonic movements occurred towards the end of the Stephanian B which resulted in giving rise of erosional activity of ancient streams.

Key words: seismic profiles, ancient river valleys, the Mšeno–Roudnice Basin.

INTRODUCTION

The Mšeno–Roudnice Coal Basin is a part of the Central Bohemian Carboniferous Coal Basins (Fig. 1). It is entirely hidden below platform Upper Cretaceous siliclastics up to 300 m thick. The Carboniferous fill of the basin is composed of four main lithostratigraphic groups: Kladno Formation, Týnec Formation, Slaný Formation and Líně Formation (Westphalian C/D to Stephanian C). The total thickness of the Carboniferous fill was strongly influenced by pre-Cenomanian erosion, ranging from several tens of metres in the south up to nearly 1 km in the basin centre. The basin was explored by nearly 55 deep boreholes drilled down to the crystalline basement. Several tens of shallower boreholes were completed within the Carboniferous fill. The purpose of drilling was the exploration of coal reserves.

Logging were carried out in all drilled boreholes in the Mšeno–Roudnice Basin, giving bases not only for precise identification of the occurrence and quality of coal seams, but also for further geological studies in individual boreholes and whole structures.

The seismic works in the Mšeno–Roudnice Basin were carried out in 1979–1981 by the Vibroseis crew of Geofyzika Brno. The results have been presented as the time and depth sections. These works were aimed at the coal prospecting problems (tectonics and geological structures), the following results concerning the fossil river net were obtained later.

METHODOLOGY

The manifestation of filled fossil channels in seismic sections is generally uniform. A channel appears to be a limited zone of wave distortion within a given eroded formation. Under favourable conditions, a curved reflection can be observed corresponding to the bottom and slopes of a channel. However, complicated geological structures and other factors including the seismic data processing can impede the identification of individual fossil channels: the reflections corresponding to the slopes of a filled ancient valley can disappear or, on the contrary, can be multiplied, etc. On the other hand, the areal character of

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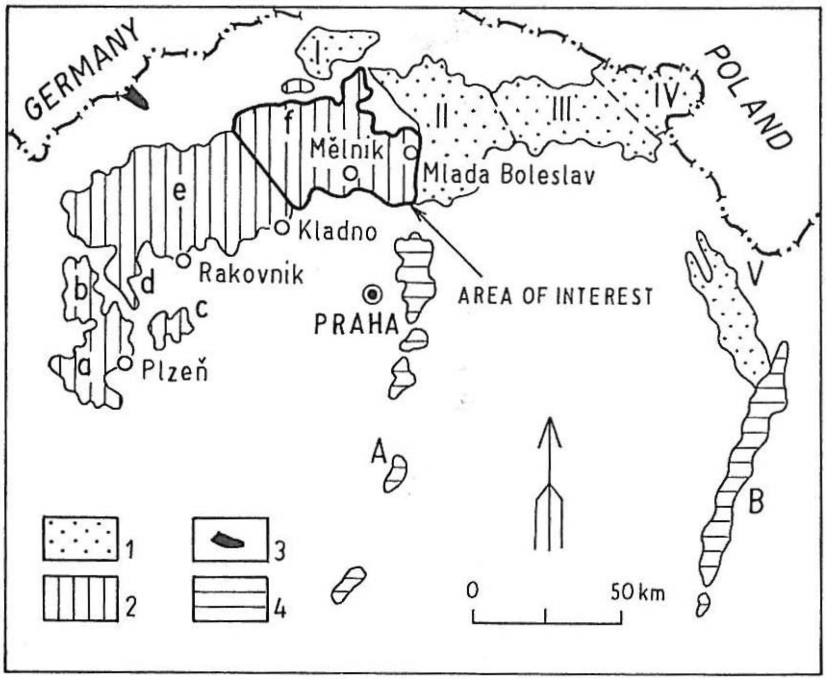

Fig. 1. Sketch map of the limnic Permo-Carboniferous regions and basins in the Czech Republic (modified after Pešek, 1994)

1 — Lusatian upper Palaeozoic basins (I — Česká Kamenice, II — Mnichovo Hradiště, III — Krkonoše Piedmont, IV — Intra Sudetic, V — Orlice); *2* — Central and Western Bohemian upper Palaeozoic basins (a — Plzeň, b — Manětin, c — Radnice, d — Žihle, e — Kladno–Rakovnik, f — Mšeno–Roudnice); *3* — Krušné Hory upper Palaeozoic; *4* — furrows (A — Blanice, B — Boskovice)

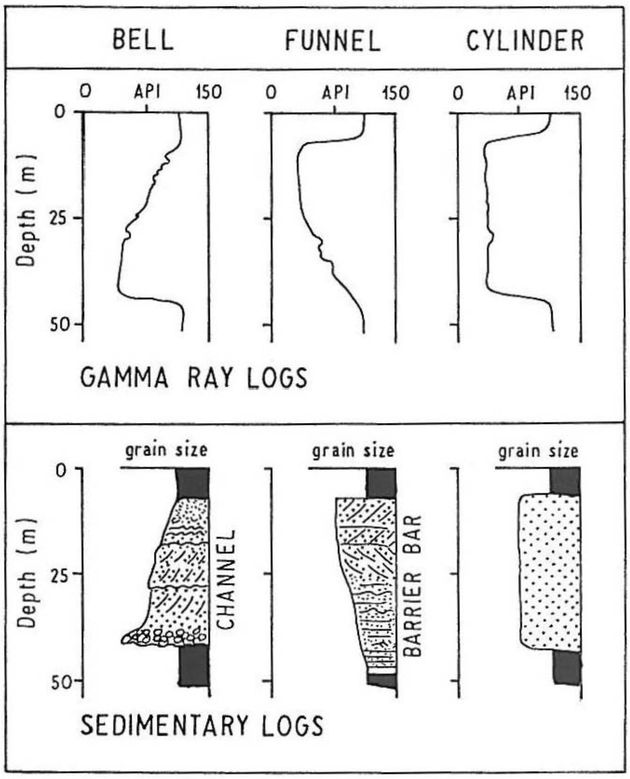

Fig. 2. The three principal gamma-ray shapes and their corresponding sedimentary interpretation (after Serra and Sulpice, 1975)

fossil stream net facilitates, thanks to the numerous seismic lines, the location of these phenomena.

The symptons indicating an ancient river valley position can be summarized briefly in this way:

— the upper limit of the valley is horizontal or situated concordantly with reflections of overlying beds,

— both valley slopes can be visible as curved oblique reflections,

— part of a seismic section corresponding to the valley zone is limited all-round,

— the wave field within the valley zone differs from that one in overlying, neighbouring and underlying beds,

— the reflection system of valley sedimets and that one of surrounding rocks are divided by the line of valley slopes,

— the valleys narrow downwards.

These symptons are often obscured by other geological structures. Sometimes, they may be also affected by data processing.

The set of the measured geophysical logs offers also information, besides the determination of the coal seams, for sedimentological purposes (Mareš *et al*., 1997). The values measured by geophysical logs are, under specific conditions, proportional to the size of the grain of the sediments (Fig. 2). If the log curves are drawn in suitable form, they should correspond by shape to a sedimentological profile composed by the geologist from the borehole core.

GEOPHYSICAL DETECTION OF ANCIENT RIVER VALLEYS

Ancient erosion valleys filled up by stream-laid sediments represent anomalous elements inside an ordinary geological section. Geological formations are suddenly interrupted by an eroded zone and the sediments forming the valley filling do not correspond to the ones existing at the same depth level outside the valley. The lateral difference in results of drilling may then result in unreal explanation of known geological data. To solve these problems, reflection seismics and well-logging were applied.

The reflection seismics can recognized an ancient river valley in the seismic depth sections. The structure of a sedimentary formation, noted for more or less continuous system of generally subhorizontal reflections, is interrupted in the area of an ancient valley again. This effect is often obvious even in the case of land sediments, where reflections are substantially more irregular then those of marine or limnic sediments. The area between drifted reflections and the upper limit of the valley can be called the valley zone. The upper limit lies at the level of ancient earth surface at the time of a corresponding hiatus, when the areal sedimentation was interrupted for some time. Other parts of seismic section, above and below the valley zone, are not disturbed and they contain more or less continued reflections.

The geophysical logs make possible to define with more precision the sedimentary facies considering not only the values but also the shapes of the measured curves.

DISCUSSION AND RESULTS

The distribution of the boreholes as well as the seismic profiles, together with the final interpretation of the ancient channels, is shown on Figure 3.

The Figure 4 demonstrates the seismic depth section from the part of the profile 19A/80 without interpretation (above) and with marking of the course of an ancient river valley and its upper limit (below) at –350 m. The depth of this channel reaches about 140 m at 3.8 km. The continuation of the same channel to the west is visible on Figure 5 on the seismic line 18A/80 in the range between 1.4 and 2.6 km. Upper boundary (i.e. the hiatus level) at –360 m and the maximum depth reaches about 170 m at 2.0 km. Borehole Sš-1, placed at the margin of this channel, found that the upper part of the Slaný Formation was missing while the red-coloured psammitic basal part of the Líně Formation (partly the channel fill) was 60 m thick.

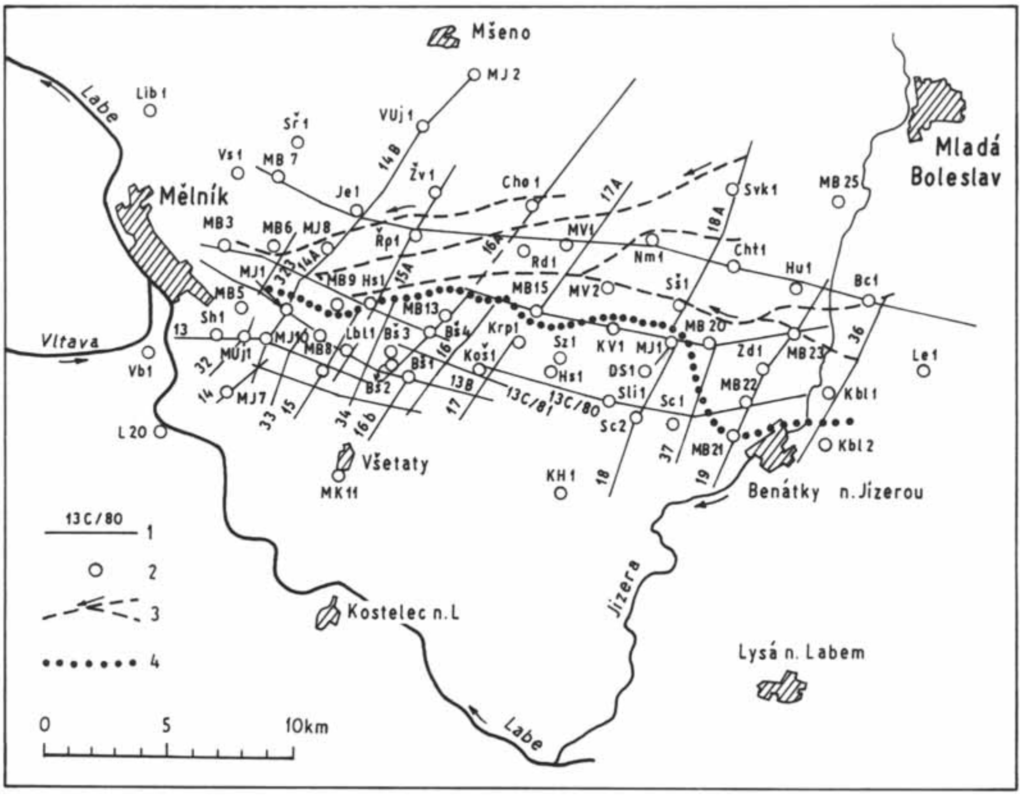

Fig. 3. Situation of the seismic profiles and boreholes in the area Mělník–Mladá Boleslav

1 — seismic profile, *2* — borehole, *3* — interpreted courses of the fossil river net, *4* — southern boundary of the Líně Formation

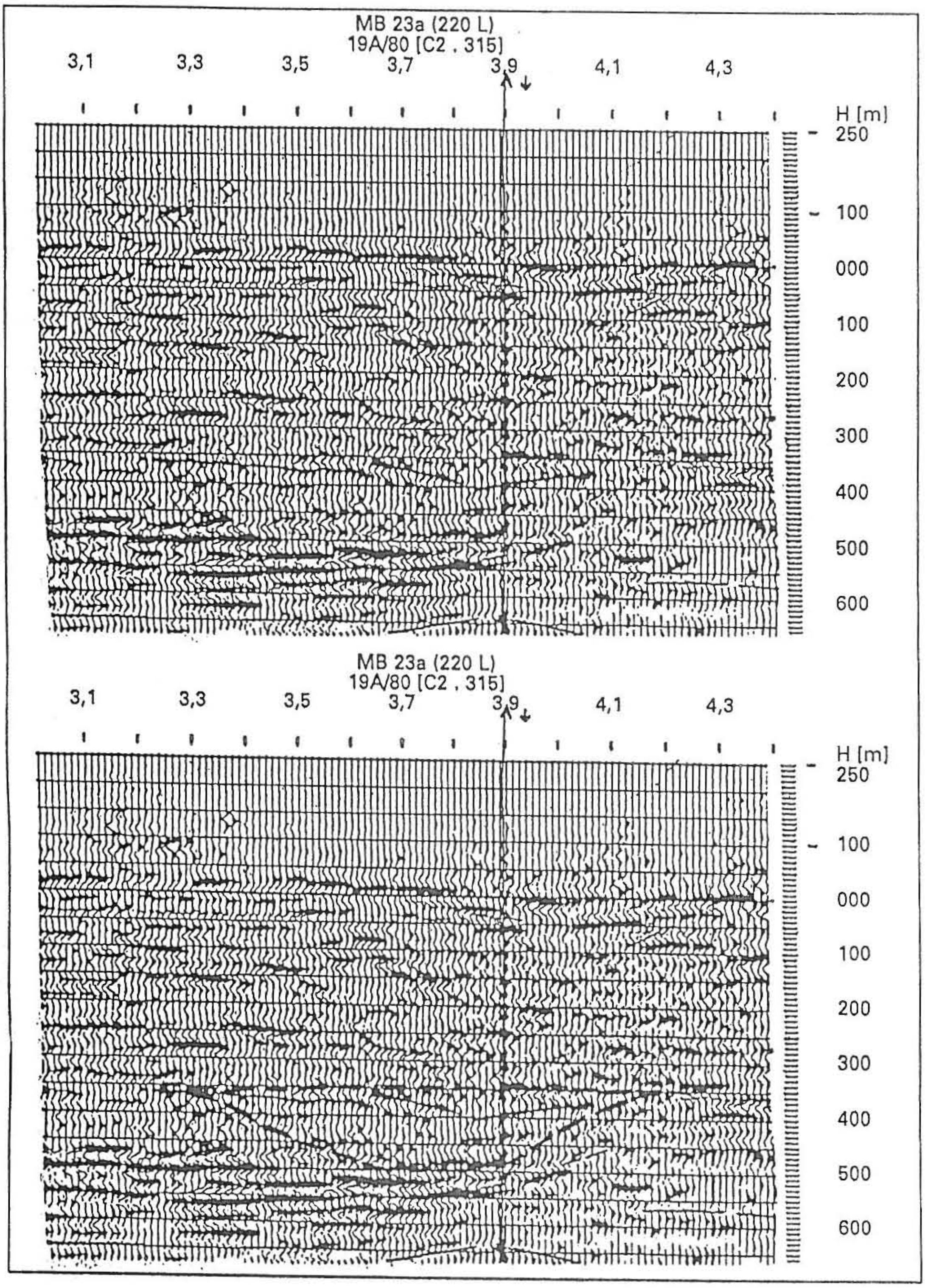

Fig. 4. The seismic depth section by the borehole MB-23 side, part of the profile 19A/80; above: without interpretation, below: with the fossil channel indication

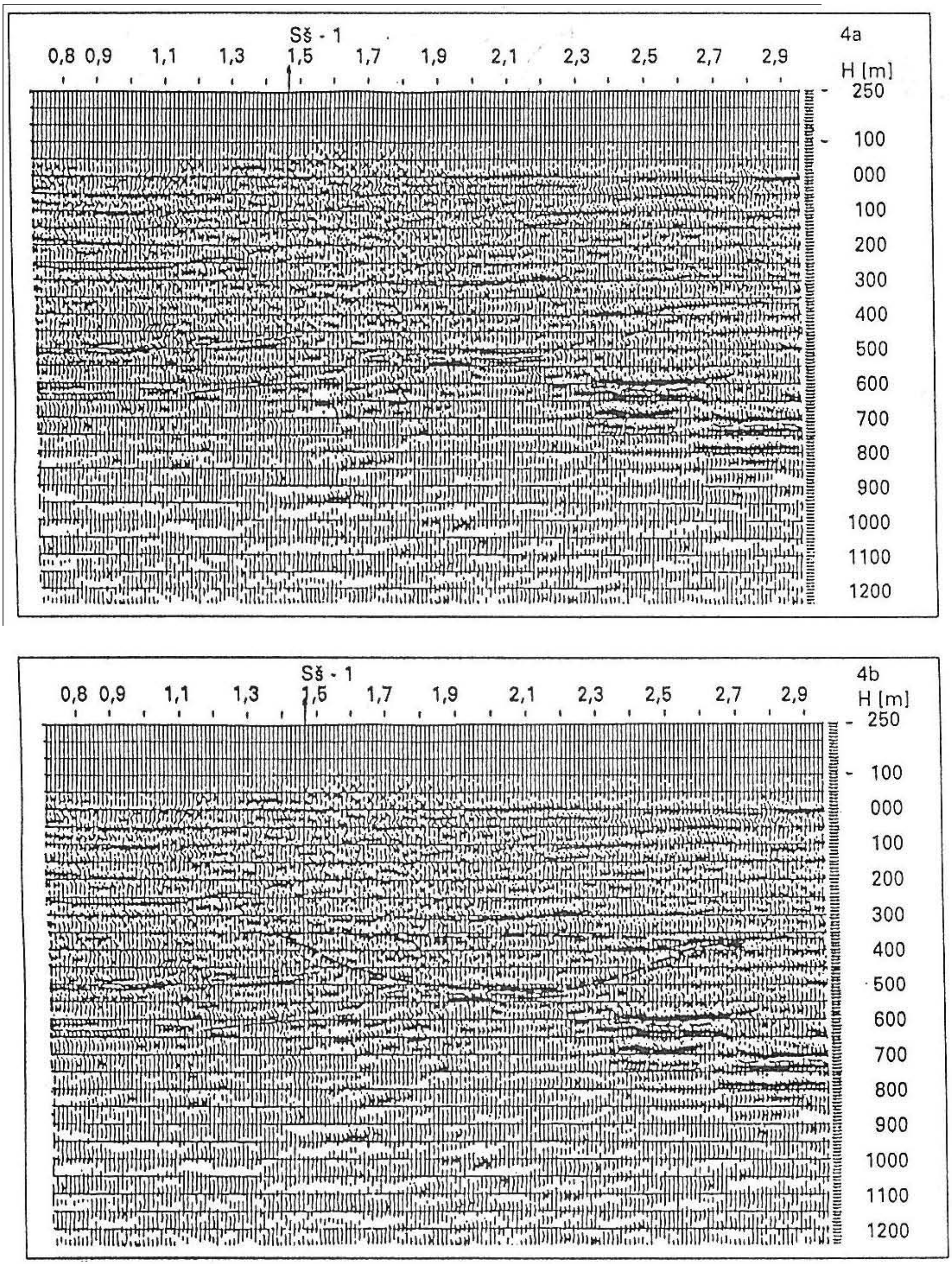

Fig. 5. The seismic depth section in the surroundings of the borehole Sš-1, part of the profile 18A/80; above: without interpretation, below: with the indication of the channel course and its upper boundary

The logging curves from this borehole Sš-1 show thick complex 60 m of sandy sediments (Fig. 6).

The fossil stream system map (Fig. 3) was put together on the basis of all ancient channel indications at the given level, corresponding to the Stephanian B/C hiatus. General E–W direction of channel system suggests the sunken area to be westwardly from the town Mělník, where the depth of fossil valleys is almost constant, about 200 m.

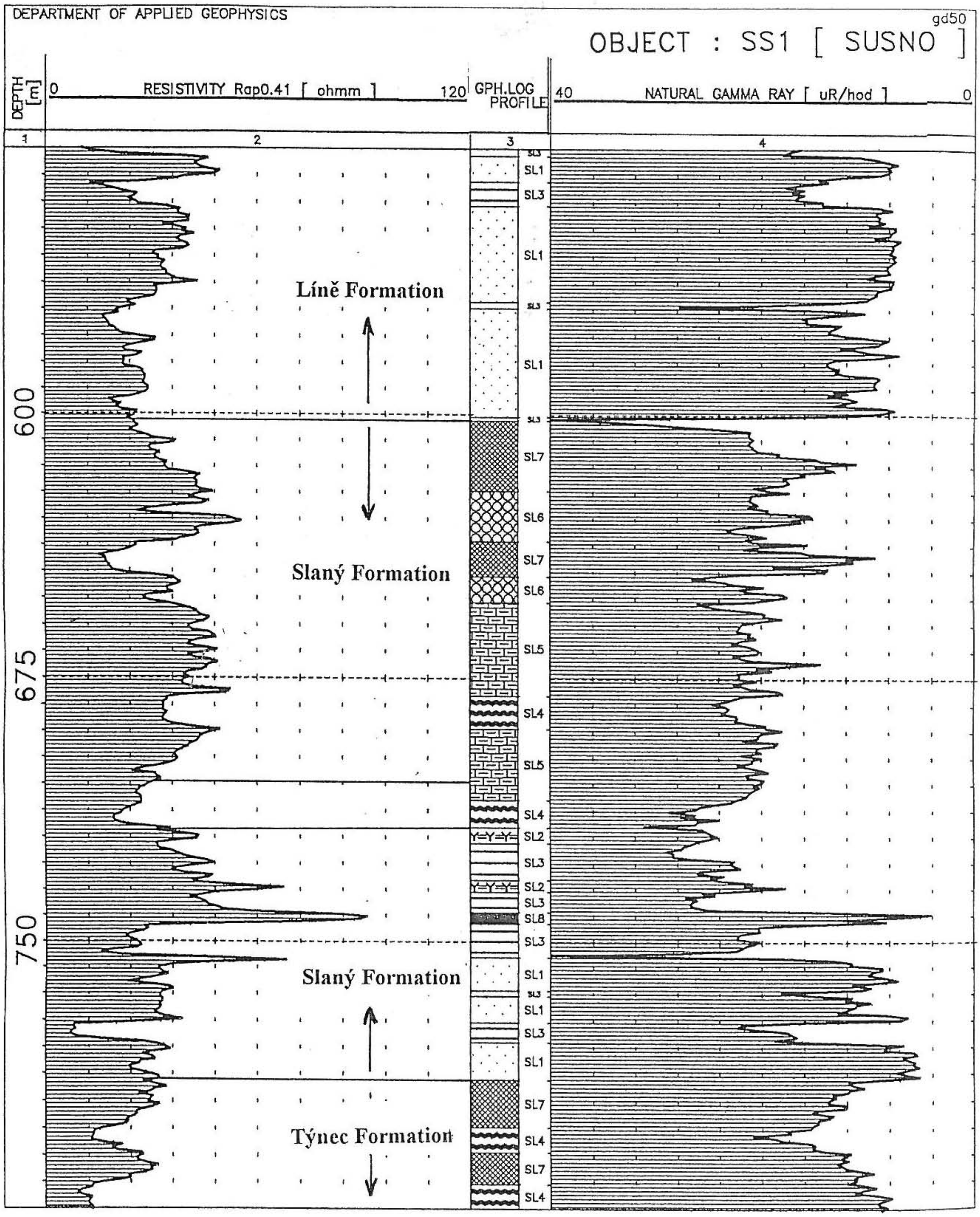

Fig. 6. Determination of the sedimentary lithofacies, according to logging from the borehole Sš-1

SL-1 — fluvial facies, SL-2 — crevasse splay facies, SL-3 — aluvial facies, SL-4 — lacustrine facies, SL-5 — rhythmic sedimentation, SL-6 — coarse rhythmic sedimentation, SL-7 — deltaic sedimentation, SL-8 — coal

CONCLUSIONS

The presence of ancient river valleys can affect the geological interpretation significantly. The level of the upper limit of river valleys usually corresponds to the level of a long-lasting stratigraphical hiatus with corresponding weathering effects on the earth surface of the time. As a result of erosion activity, some important stratigraphical horizons can disappear locally or may appear at apparently higher stratigraphical position. This case comes when the thickness of valley sediments (at the level of the eroded underlying horizons) is included mechanically into the set of overlying sediments, which should result in unexpectingly high position of a given horizon. These and other geological facts are usually explained by simple tectonic movements. However, the presence of ancient river valleys signalized either an extent tectonic movement of a given area (uplift) or a subsidence of a neighbouring area. In this way, the identification of ancient river valleys submits new information on the geologic processes in the region under study.

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