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New information on the Markušovce - Šafárka gypsum and anhydrite deposit (Eastern Slovakia)

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Abstract. Results of new geological researches on the evaporite deposit Šafárka (Eastern Slovakia) enable a substantial re-evaluation of its economical significance. Within the deposit, gypsum and anhydrite form regular and qualitatively distinguishable technological subtypes of raw material that fulfil different industrial requirements.

Key words: Permian–Triassic, gypsum, anhydrite, Northern Gemericum

Introduction

The deposit Markušovce – Šafárka is a part of the Spis deposit belt of anhydrite and gypsum. Nowadays it is known under the name Spišská Nová Ves - Nová štôlňa (New adit) (Michalko, 1994).

The deposit has been known since its finding in thirties of this century as well as on the basis of more geological-prospection works performed later. The latest data about the deposit were obtained in the frame of the project "Šafárka - prospection and assesment of open casting gypsum, prospection etape (Jančura et al., 1997)."

Location, position and shape of the deposit

The deposit Markušovce - Šafárka is located in the area between Zadna dolina valley, Rysovec, Nova stolna adit and a mountain crest Gretla - Trubačovec southerly of Spišská Nová Ves and northerly of Hnilčík. It is a part of the north gemeric evaporite formation. The deposit is formed in the stratigraphic horizon of sedimentary sulphides identical with sulphides occurring in the anhydrite - gypsum deposit of Novoveská Huta.

The deposit Markušovce - Šafárka is bound by a fault systems governing the characteristic block structure of the area. The southern margin of the area is formed by Muráň or Gretel (Daniel et al., 1985) E - W fault having a character of an oblique thrust. From the south the deposit is bound by a system of oblique normal faults of NNW - SSE direction along the mountain crest Zompy. The system of normal faults, extended in the line from Teplička to Bindt, makes the eastern boundary of the deposit.

The shape of the deposit is fully determined by the spatial distribution of the above mentioned faults. The tectonic structure renders a possibility to divide a block of open casted resources in the area of Zadná dolina valley, which is uplifted to the level 15 - 20 m under the surface.

Lithostratigraphic characteristics of evaporite horizon

The evaporite horizon is associated with the uppermost sequences of Nová Ves Formation (Novotný et al., 1987) belonging to the Krompachy Group (Bajaník et al., 1981). The upper boundary between the evaporite horizon and the Lower Triassic rocks is not exactly given because of different interpretation of conglomerates overlying shales containing evaporites in the larger surroundings of Novoveská Huta.

Nová Ves Formation is dated to the Upper Permian on the basis of palynologic assemblage (Planderová in Václav et al., 1980). The isotopic analysis performed on the sulphur from evaporitic horizons mostly approximates to the Upper Permian - Lower Triassic age (Kantor, 1982).

Nová Ves Formation contains deposits with a conspicuous fining up grain size trend (Vozárová et al., 1988). Novotný et al. (1987) divided the formation to the Strážany and Biela Voda Beds. Strážany Bed commences by polymict conglomerates having a gradual transition to sandstones, shales and aleurites upward. Vojtechovce horizon, bearing Cu and U mineralization, is divided separately. Strážany Beds pass to evaporite lithofacies of Biela Voda Beds. These beds are typical by

occurrence of gypsum, anhydrite and localy also halite and sylvine (Maheľ et al., 1973). Fragments of complementary claystones and siltstones are typical too. A part of the evaporite lithofacies are layers of intraformational breccias containing clasts consisting of sediments or dolomites (Karoli, 1992; Turanová et al., 1993; Michalko, 1994). Evaporites pass to porous yellowish brown massive carbonates (termed as rauwacks) upward. The carbonates contain raddles of green or redd clayey rocks and grey dolomites. (Fig. 1).

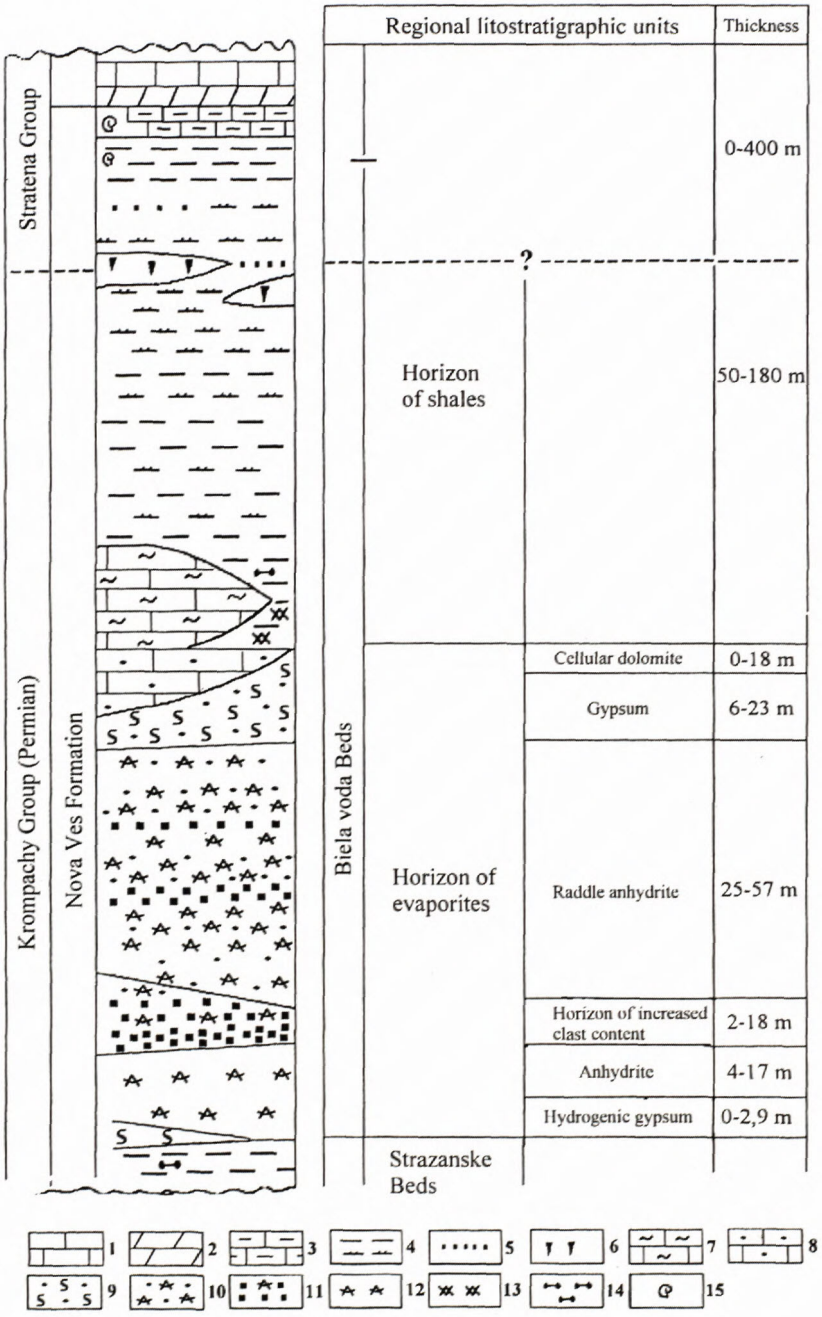

Fig.1 Schematic litostratigraphy string of Evaporites horizon from Markušovce - Šafárka deposit.
1 – limestones, 2 – dolomites, 3 – marly limestones, 4 – shales, aleurolitics, 5 – sandstones, 6 – quartzose sandstones, 7 – marly limestones and shales, 8 –- cellelar dolomites (rauwackies), 9 – gypsum with clastic admixture, 10 – anhydrite with clastic admixture, 11 –- horizon with higher abundance of clasts, cemented with anhydrite, 12 – anhydrite, 13 – gypsum (veinlets), 14 –- nodules of dolomite, 15 – occurrence of fossils.

A genetic connection between the occurrence of evaporites and cellular carbonates is assumed on the basis of the spatial relationship (Maheľ et al., 1956). The transition of cellular carbonates to overlying marl phyllites is gradual. The bedding with constant bed thickness is well developed in the Nová Huta Formation deposits, especially in evaporite facies. The deposits are characteristic by the development of small cycles in the range from 1 to 10 m and mesocycles in the range from 10 to 50 m (Vozárová et al., 1988).

The formation belonging to the Lower Triassic, which occurs in the deposit area, crops out as erosive relics especially in the northern part of the area. The lowermost members are rhythmically alternated beds of violet, green and grey slates, sandy slates and sandstones. The facies changes upward where marls, marl limestones and slates of grey to greyish green colour appear (Campanian). The upper part of the formation consists of bedded limestones of Campanian (Biely et al. in Fusan et al., 1967). The Lower Triassic formation underlies erosive blocks of Middle Triassic carbonates forming peaks of more conspicuous hills (Okruhlovec and others). The carbonates are represented by underlying dark dolomites and limestones of Anisian age and pale limestones of Anisian - Ladinian age (Novotný et al., 1985).

Evaporite horizon of the part of the deposit Markusovce -Šafárka was recently petrographically described (Faryad in Jančura et al., 1997) in the borehole Sa-1 (depth 126 m) located in the Zadná dolina valley. The gypsum and anhydrite occur as formation containing quantitatively variable clast admixture consisting of slates without or with organic matter content, dolomites, quartz and sandstone. Clasts have various shapes, size and they are irregularly distributed. The fragments up to the size of 1 cm prevail, occasionally fragments up to 5 cm occur too. More important concentrations of NaCl or KCL have not been confirmed in evaporites and there has not been found a dolomite having a form of massive layer. The occurrence of anhydrite and magnesite inclusions sugests the origin of a part of anhydrite by chemical alteration from dolomite. Magnesite, which includes anhydrite in gypsum, shows the origin of gypsum by anhydrite gypsification in zones overlying and underlying evaporites. Anhydrite crystals are clear, without admixture of other components, which may suggest their recrystallization from sedimentary anhydrite during the diagenetic process.

Preserved sedimentary structures, clast character, hints of graded bedding and erosive bases of individual depositional rhythms point to depositional conditions. The evaporite deposition occurred most likely on a shallow, tectonically active basin margin with periods of tectonic activity and stable depositional conditions. The near-base anhydrites are the product of more quiet development, the so called raddle anhydrite and/or anhydrite conglomerates and breccias having anhydrite matrix are the product of the development during partial tectonic movements (Karoli, 1993).

The correlation between stratigraphic horizons and mineralogic composition of evaporite formation between individual prospection workings implies the greatest depth of the raddle type of evaporite formation in the area of Zadná dolina valley. It is possible to observe here more than three times repeated rhythms of graded bedding containing more massive basal layer with prevailing clastic part in the bed overlying anhydrite. The raddle horizon diminishes toward north and west. The evaporites form a compact layer of anhydrite with gypsum in the borehole GR-5. Evaporites do not have clastic admixture here. The overlying rocks locally contain gypsum in veins, aggregates and hems.

The evaporite characteristics differs in the only confirmed occurrence in the Markušovce valley at the locality Slivníky (borehole 229), easterly from the prospection area. Under the slates, interfingered by gypsum, the evaporite horizon commences in the 232.1 - 244.2 depth interval by a compact anhydrite having weakly hydrated zone in the upper part. In depth 244.2 - 268.1 anhydrite interfingered by slates is developed. In the depth interval 268.1 - 276.0 anhydrite contains fragments of greenish slates. In the depth 276.0 - 279.7 compact anhydrite occurs.

The correlation of evaporites at the locality Markušovce - Šafárka and more distant deposits in the area of Novoveská Huta, Biele Vody, Poráčska dolina valley and the area northerly of Rudňany and Smizany reveals facies originated in different depositional environments.

Distribution of evaporite minerals

The evaporite formation in the area of Nová stôlňa adit – Šafárka – Zadná dolina valley may be characterized from the base upward as follows:

a) Chemogenous anhydrite layer, localy hydrated to gypsum on the base of evaporite formation. The admixture, irregularly impegnated in anhydrite, is mostly represented by dolomites. The boundary between anhydrite and dolomite is transitional, anhydrite grains contain fine dolomite inclusions on their hem.

b) The middle bed of raddle anhydrites, represented by graded and rhythmically bedded conglomerate- and breccias-evaporites, commences by the prevailing clast abundance comparing to anhydrite matrix in the lower part. The boundary between the chemogenous layer and anhydrite bed with prevailing clast content is sharp. suggesting an abrupt change of depositional conditions.

The size of conglomerate clasts varies, the largest ones are up to 5 cm. The clasts are variably rounded. Between lithotypes, better rounded slate clasts prevail above the less rounded carbonates comprising mainly dolomite. In the upper part of the section quartz occasionally occurs. The anhydrite matrix consists of anhydrite grains having marmor structure. Diagenesis is indicated by secondary anhydrite in the form of veins, aggregates, metacrystals, redeposited quartz in the form of veins and hexagonal metacrystals and magnesite (Faryad in Jančura et al., 1997).

Conspicuous indication of redeposition in the form of chaotic structures and irregular bedding has not been observed in the layer of raddle anhydrite. In boreholes Sa-1, Sa-2 and Sa-3 primary bed structures are preserved without discordance, even on the erosive bases (?) of individual depositional cycles with graded bedding. The changes in measured values of foliation cleavage in one section are gradual and they are consistent with plikatives deformation of evaporite formation. The special phenomenon is the preffered clast orientation.

c) The gypsum horizon is locally developed in the upper part of evaporites. The gypsum is analogous to raddle type of evaporites comprising fine-grained clasts. It occurs along a hydrated zone parallel to muran (gretel) fault. It extends from Zadna dolina valley to Nova stolna adit and further on to the west.

d) The evaporite formation ends by an irregularly developed bed of cellular dolomites which is assumed to be a part of Biela Voda Beds. This horizon almost always directly overlies evaporites. Locally the horizon individually occurs in the overlying slates and sandstones (borehole Gr-4).

Tectonic structures characterized on the basis of geophysical investigation

Ten NE-SW profiles were performed during the geophysical investigation (Komon in Jančura et al., 1997). The geophysical map of rock resistivity has been made. Except of surface resistivity map, three subsurface horizontal sections were made in depths 10 - 15 m, 30 - 40 m and 80 m. Resistivity isolines show conspicuous zones of different resistivity. The low resistivity zones point to a strong watering, of tectonic structures and it is possible to compare them with azimuths of dislocations founded on the surface.

Active springs, swamps and peats were found on the surface during the mapping in the area of deposit Safarka. They point to the outcrops of water-bearing structures. The communication between above mentioned water sources can be confirmed by correlation of directionaly most frequent geophysical structure zones of resistivity and founded dislocation in the surroundings of the deposit (Sasvári in Jančura et al., 1997).

Geophysical resistivity profiles, made on the basis of horizontal geophysical sections, show important subvertical fault structures coinciding with main structures of tectonic deformation.

Model of structural pattern of the Šafárka deposit

The comparison of geophysical resistivity measurements (Fig. 2a-d) at evaporite economy deposit Safarka, tectonic structures of dislocated character in the northern part of the area, outside the deposit area, and water-bearing structures cropping out on the economy deposit area (Fig. 2e) show that:

- The economy deposit is deformed at least by three systems of subvertical dislocations of NW-SE, NE-SW and NWW-SEE direction. The azimuth variance of these directions is in the range of 10 - 25 degrees. The reason of this variance is probably caused by mutual rotation of individual blocks.
- The deposit is deformed at least by one subhorizontal, resp. slightly inclined tectonic zone in the depth level under 50 m. Mylonite zone has been recovered by the borehole Sa-1 in the depth 49 - 50 m. The horizontal geophysical section in the depth 80 m shows substantially more conspicuous NNE-SSW and NE-SW zones of lower resistivity, other directions are less conspicuous. It indicates two subhorizontal blocks separated by a mylonite zone in the distance of ca. 50 depth meters.
- The more essential deformation of the deposit with the occurrence of more dense dislocation structures is in the southern part nearby the Muráň Fault. This area is most conspicuous watered.
- Subhorizontal and subvertical dislocation results in high amount of blocks in the deposit. This suggests the mutual rotation of blocks respectively sinking of some structural blocks of the deposit.

The model of above mentioned structural pattern deposit probably originated by sinistral shear of the shear zone of Muráň Fault. Incompetent rocks in the area of anhydrite deposit Šafárka got sigmoidal course of foliation. More competent anhydrite layer has been formed to asymetric megaboudin -shear lense as a result of higher values of shear strain. This megaboudin - shear lense represents the deposit Šafárka.

Sinistral orientation of the shear shows model conditions of a simple shear and a formation of extension and compression structures. Directions of these structures are consistent with geophysical structures with low resistivity, the occurrence of surface springs, karst sinks and swamp zones.

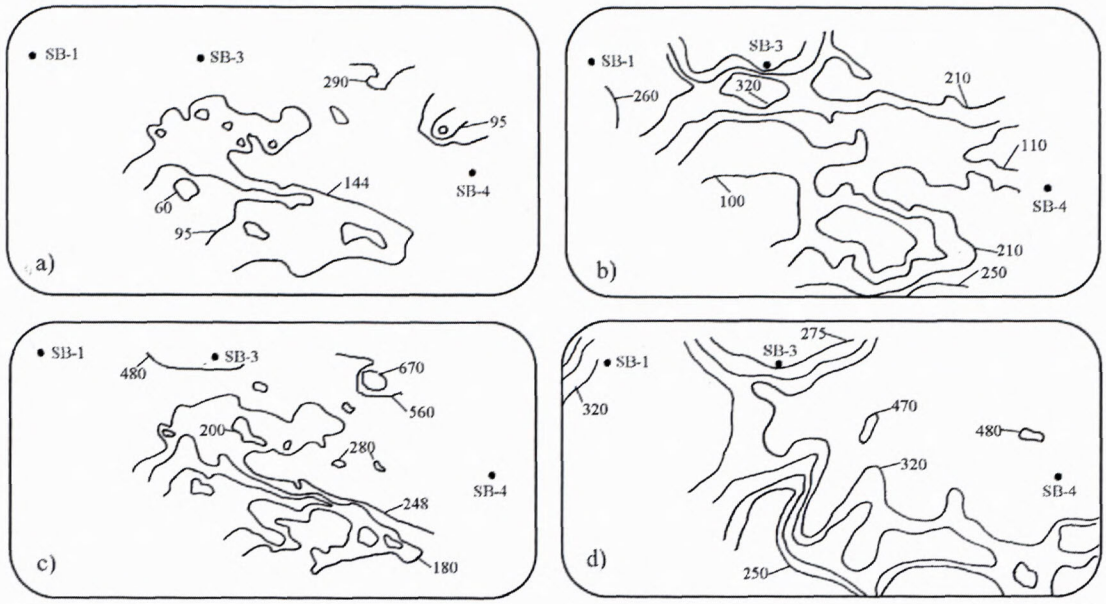

Fig. 2a-d Šafárka deposit. Geophysical sketches of izolines of low resistivity. a-surface (335-60 OHM_M), b-horizon 10-15 m (576-100 OHM_M), c-horizon 30-40 m (676-100 OHM_M), d-horizon below 80 m (487-250 OHM_M). SB-1, SB-3, SB-4 are boreholes.

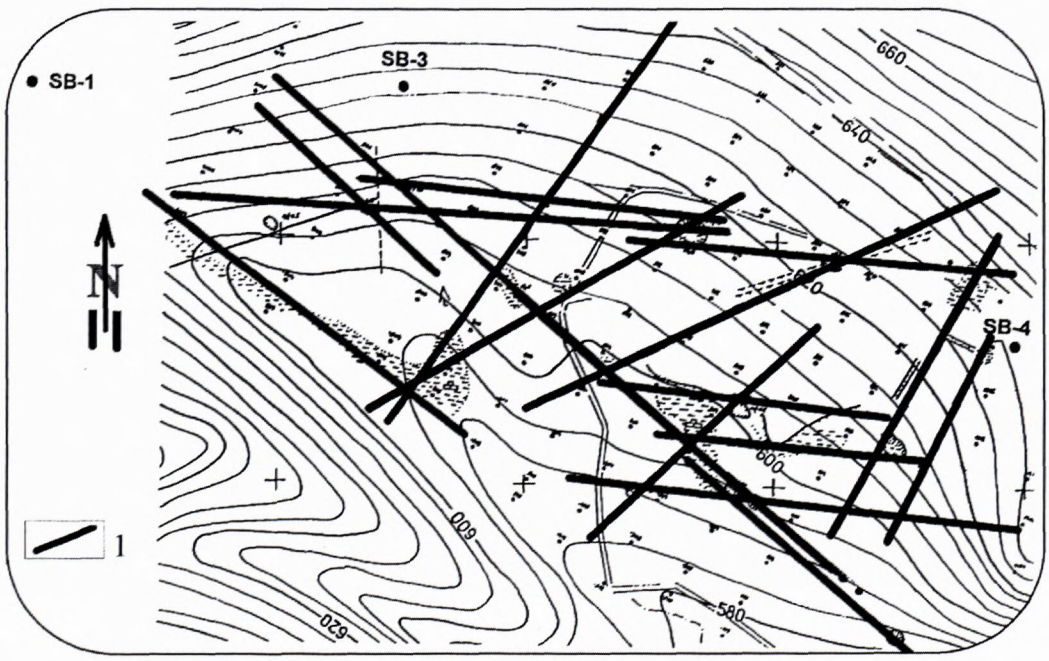

Fig .2e Šafárka deposit. Coincidence of geophysical structures with low resistivity (by fig. 2a-d) with surface springs, karst sinkhole and zones of sloughs.

Conclusion

New geologic-prospection works at gypsum and anhydrite deposit Markušovce - Šafárka enabled revaluation of economic importance of the deposit. The gypsum and anhydrite form regularly distributed and qualitatively discerned technological subtypes of the raw material. The raw material fulfill the requirements for more posibilities of industry use. Specially interesting type of raw material is open casted gypsum at locality Zadnádolina valley.

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