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Catastrophic deposits in the Bulgarian Lower Cretaceous

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Catastrophic sediments are formed under the influence of sharp and short-term natural phenomena — earthquakes, tsunami, hurricanes, storms, submarine slumps, continuous torrential rains etc. They could be caused by different reasons (relief and land dynamics, shelf and continental slope, sharp climatic changes, impact and orbital influences etc.) which have outside (allocyclic) character in respect to the deposition. These deposits are named catastrophic because they are a result of the very short-term phenomena (Ager, 1974, 1993; Einsele, 1991; Seilacher, 1991).

The sediments discussed are genetically and dynamically determined and characterized in diverse Lower Cretaceous cross sections in Bulgaria. The basic types of catastrophic deposits in the Bulgarian Lower Cretaceous record are: debrites and diamictites with chaotic structure, very thick extensive debrites, as well as tempestites and beds with hummocky cross stratification (HCS). Specific event deposits are so called fluxoturbidites, whose origin is connected to the combination between turbiditic curents and significant submarine slumping. Generally these are thick-bedded deposits with slightly expressed graded stratification, often with chaotic structure and practically without any marks on the lower bed surface of the sand beds.

The following types of catastrophic deposits were established in the Lower Cretaceous sections in the region of the Central and Eastern Balkan: 1) mass debris flow deposits — debrites and diamictites (or mixtites); 2) tempestites; 3) sediments with hummocky-cross-stratified bedding; 4) submarine slumps and slumping. Their formation is conditioned by the specificy of the palaeogeographic environment.

Only sediments from the edge of the shelf, continental slope and continental foot are preserved in the recent geological sections. The post Early Cretaceous denudation and tectonics destroy the first and a great part of the second level of sedimentation.

General appearance of the lithological facies in Fore Balkan in the range of Upper Tithonian-Valanginian is outlined by the development of flysch sediments, from South to North represented as follows: coarse flysch, sandy flysch, typical flysch and subflysch (Николов, Хрисчев, 1965; Рускова, Николов, 1984). Due to the high and often variable dynamic of sedimentation a part of the basin's continental slope often penetrates to the north reaching the flysch zone. This is proved by series of lenses of coarse clastic debrites that tear through the well-stratified sediments of the Zlataritsa and Cherni Osam Formations.

The most typical phenomena of catastrophic deposition are observed in the cross-sections in Troyan, Gabrovo and Elena districts. For example, in the section south-west from the river Vidima and east from the river Cherni Osam and its tributary the river Krajovitsa, a characteristic facial junction is observed. Facies of the coarse terrigenous Kostel Formation with its typical debrites are interlaced with the sediments of the Zlataritsa-Cherni Osam Formation. In the section along the river Krajovitsa mass debris flow deposits are established: debrites or diamictites, mixtites, rare tempestites and seismites. The debrites are represented mainly by conglomerates and gravelithes, frequently with lense-like shape but dominantly with chaotic structure among the sandy-silty-clayey mass. Inverse gradation bedding is the most common in the conglomerates and grave-

lites. Debrite packets reach up to 100 m, rarely more, but usually are 10-15 m thick. Huge submarine slumps of strongly mixed sediments close to the probable average composition of conglomerates, gravelites, sandstones, siltstones and silty marls are very often observed among these deposits (Николов, Хрисчев, 1965). Exotic blocks of igneous and metamorphic rocks present in these submarine slumps, as well as pieces and fragments of coral and algal limestones. Beside from the main body of the submarine slumps spherical sandy formations similar to concretions are frequently observed. They are of storm-roller (or flow roll) type — a result of deformations induced by tension or specific influence of mud flows accompanying the submarine slumpings.

Debrite packets from this section alternate with turbidite sediments, represented by three-component cyclothems: sandstones, siltstones and silty marls. Layers of silty clayey limestones are rare. The thickness of the turbidite packets is 75-150 m (Николов, Хрисчев, 1965; Николов, 1994).

Catastrophic deposits are known from the sections of the Kostel Formation in the Southwestern Bulgaria too, where they are represented by debrites (conglomerates, gravelites and mixtites) and olistolites (i.e. extensive debrites) (Сапунов et al., 1985; Загорчев et al., 1989).

Submarine slumpings are observed in the sections of the Cherni Osam Formation too, marked by strongly mixed rocks (mixtites). Strong deformations are established in them. In the southern outskirts of the town Troyan in the uppermost (Berriasian) part of the flysch the phenomena of the submarine slumpings acquire impressive dimensions (packet thickness is tens of meters). In the same stratigraphic interval large submarine slumpings are developed along the valley of the river Yantra, southernly from the town Gabrovo (quarter Yabalka), along the rivers Mijkovska and Kostelska. A detailed description of the type-section of the Kostel Formation had been published recently (Николов, 1997), where catastrophic deposits are observed in many levels — debrites, submarine slumpings of mixed rocks (mixtites) accompanying with specific for this phenomenon deformations, as well as olistolites (extensive debrites).

Very outstanding is a submarine slumping in the Berriasian section (zone *Tirnovella occitanica* — zone *Fauriella boissieri*) in the valley of the river Mijkovska, north-western from the village of Mijkovtsi, Elena district. There, about 100 m under the old fulling-mill, blocks of sandstones, coral, algal and detrite limestones are described among a silty-sandy matrix. Exotic pieces are outlined by the matrix and there could be observed deformations as a result of the slumping.

A second temporary level of catastrophic sedimentation is established in the Upper Valanginian sections between the rivers Veselina and Osam (Николов, Хрисчев, 1965; Пимпирев, 1989; Николов, Цанков, 1998) where debrites, large submarine slumpings with deformation of the sediments and inclusions of huge exotic blocks of coral, algal, hetetid and biodetrite limestones are observed.

Pimpirev (1987) first showed the channel genesis of the Batoshevo unit. As the later studies showed (Николов, Цанков, 1998), the main canyons where the debris was slump are (from the north to the west): Vaglevtsi, Gabrovo, Batoshevo. Strong activation of the debris flows again is induced by allocyclic factors, including earthquakes in the shore zone.

Vaglevtsi and Batoshevo canyons are the most significant whereas Gabrovo canyon is more weakly expressed. Beside these canyons, in the hill area, thick sandstone trains had formed and under the continental slope — turbidite fans. The fact that Batoshevo Formation shows a beads-like distribution — thicken parts with conglomerate deposits in the canyons and slender parts with sandstone trains on the hills could be explaned precisely by the formation in a system of canyons-flat hills. According to the distribution of dominantly sandstone sediments and in respect to their structures, the areas between the canyons could be supposed to have a relief of flat hills above which sedimentary processes are tidal dominated and characteristic with the development of sand banks and sand ridges. (Miall, 1990). The very fact that mixed (wacke) rocks, practically without significant sandstone beds, occur northerly from the hamlet Sadinata at the same stratigraphic level corresponding to the age of the thick sandstone sediments along the valley of the river Veselina, proves that the considered sandstone beds between the hamlets Sadinata and Bagalevtsi have a character of submarine dunes.

The development of hummocky-cross-stratified bedding in single packets of the Batoshevo Formation in different sections is an indication for a significant role of the storm activity during the formation of these sediments.

Tempestites and sandstone-marl alternations with hummocky-cross-stratified bedding which origin is a result of storms and hurricanes in the shelf zone are established among the Upper Tithonian, Upper Berriasian and the uppermost part of the Upper Valanginian sediments in high

sea-level. Fine layered sandy sediments, often with graded stratification present tempestites. The sediments with HCS also are formed as a result of storms, but with unimodal geostrophic flows induced by the same storm.

Mandov (Мандов, 1984) described specific structure features in a packet of Hauterivian clayey limestones from the Salash Formation westerly from the village of Krapchene, Montana district. Beds in these packets are strongly deformed into smooth wavy folds without clear vergency. Besides that they are strongly torn. In a general plane, the packet described lies over and is covered by undisturbed parallel clayey limestone and marl beds. Мандов supposed with good reason that most probably a seismic action had caused the deformation of the clayey limestone in this packet when they had been compacted but still too plastic. The same author observes similar phenomena in the Salash Formation around the villages of Salash, Chemish and Chuprene, where carbonate breccias and detritus occur. Recently observed coarse to medium grained sandstones from the Salash Formation at the village of Varbovo, Belogradchik district, certify to earthquake influence in the shore zone inducing a debris flow to the north into the zone of pelagic sedimentation.

In the valley of the river Iskar, between the Cherepish monastery and the village of Liutibrod, a full section of the Vratsa Urgonian Group crops out represented by two formations — Cherepish and Liutibrod Formations (Minkovska et al., 2001). Sediments with clearly expressed event generated features with catastrophic character caused by storms and hurricane high tide are observed among the carbonate successions of these formations. These sediments are of tempestite type. According to their texture carbonate rocks are grainstone and packstone-grainstone, poorly to well sorted. The following types of bedding could be observed: obscure stratification, parallel stratification, ripple marks, low angle cross-stratification marked according to the allochems, large-scale cross-stratification, wavy and hummocky cross-stratification, well expressed in the middle and the upper parts of the successions.

Particularly interesting debrite formations could be observed in the Eleshnitsa Formation (Upper Baremian-Lower Aptian) in the Eastern Forebalkan. These sediments were described for the first time by Николов, Хрисчев (1965). In this case coarse debrite sediments (conglomerates, gravelites and mixtites) intercalate with Urgonian reef limestones. Such interlacing of debrite deposits with Urgonian limestones is evidence for repeated action of debris flows, most probably caused by earthquakes in the shore zone. These seismic paroxisms occurred under conditions of intense lifting of the land from the south accompanying with low sea level. Debris flows had created tearing currents whose material had been distributed by longshore currents far away to the east from the main debris flow which coincides with the valley of the recent river Eleshnitsa.

In the most cases slumping of large blocks (i.e. olistostroms) in the Lower Cretaceous sections coincides with progradational sequences of low stand tracts and the beginning of transgressive sequences.

The accent here is on these catastrophic phenomena producing specific sediments, but in the studied interval in this region there are sediments showing features of "normal" background sedimentation that passes in slower rate. In all cases, the traces of the catastrophic deposits rapidly disappear northerly from the depot center of the sea basin. Only traces of storms, represented by tempestites and sediments with hummocky-cross-stratification are established in boreholes northerly from this depot center.

References

Ager, D.V. 1974. — *Palaeogeogr., Palaeoclimatol., Palaeoecol.*, 15, 83-93.

Ager, D.V. 1993. *The nature of the stratigraphical record.* 3rd ed. Jonh Wiley & Sons. Chichester, 151 p. (1st ed. 1973).

Einsele, G. 1991. In: G. Einsele et al. (eds), 313-339.

Einsele, G., W. Ricken, A. Seilacher (eds). 1991. *Cycles and Events in Stratigraphy.* Springer-Verlag. B., 955 p.

Miall, A.D. 1990. *Principles of sedimentary basin analysis.* Springer-Verlag, New York, 668 p.

Minkovska, V., T. Nikolov, D. Vangelov. 2001. — *C.R. Acad. Bulg. Sci.*, 54, 9, 69-74.

Nikolov, T., Tz. Tzankov. 1997. — *Geologica Balc.*, 27, 1-2, 3-6.

Nikolov, T., B. Peybernes, R. Ciszak, M. Ivanov. 1998. — *C. R. Acad. Sci. Paris, Sciences de la Terre et des planétes*, 326, 43-49.

Pimpirev, H. 1987. — *C. R. Acad. bulg. Sci.*, 40, 9, 83-84.

Seilacher, A. 1991. In: G. Einsele et al. (eds), 222-226.

Загорчев, И., Я. Тенчов, Е. Трифонова. 1989. — *Палеонт., стратигр. и литол.*, 27, 101-106.

Мандов, Г. 1984. — *Год. СУ, ГГФ*, кн. 1, геол., II, 78, 87-91.

Николов, Т., Хр. Хрисчев. 1965. — *Тр. геол. на Бълг., сер. стратигр. и тект.*, 6, 77-173.

Николов, Т. 1997. — *Сп. Бълг. геол. д-во*, 58, 2, 95-99.

Николов, Т., Ц. Цанков. 1998. — *Сп. Бълг. геол. д-во*, год. 59, 2, 29-36.

Пимпирев, Хр. 1989. — *Год. СУ, ГГФ*, кн. 1, геол., II, 78, 23-33.

Рускова, Н., Т. Николов. 1984. — *Geologica Balc.*, 14, 3, 3-22.

Сапунов, И., П. Чумаченко, Л. Додекова, Д. Бакалова. 1985. — *Geologica Balc.*, 15, 2, 3-61.