Microfacies of Middle Devonian (Givetian) sediments in deep wells from Northeastern Bulgaria – preliminary results

Микрофациеси на среднодевонски (живетски) седименти в дълбоки сондажи от Североизточна България – предварителни резултати

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Абстракт. В настоящата работа са представени предварителни резултати от микрофациалния анализ на среднодевонски (живетски) седименти от карбонатно-сулфатната задруга в сондажите Р-1 Ваклино и Р-119 Кардам (Североизточна България). Описани са 9 микрофациални типа, които са сравнени с микрофациалната схема на Wilson (1975), допълнена от Flügel (2004). Отделените микрофациеси характеризират различни зони (подотливна, междуприливна и надприливна) на една древна аридна приливно-отливна равнина (себха).

Ключови думи: микрофациеси, себха, карбонатно-сулфатна задруга, девон, СИ България

Introduction

The occurrence of Devonian rocks in the Moesian Platform has been proved only in oil and gas prospecting deep wells. The great part of the Givetian (Middle Devonian) succession in Northeastern Bulgaria is presented by a carbonate-evaporate sequence (carbonate-sulphate formation), that have been interpreted by Янев (1974) as deposited in arid evaporitic lagoon and shallow marine settings. In the recently published data a general peritidal (sabkha) environment has been suggested for this unit in R-119 Kardam well (Andreeva, 2007).

The present paper represents preliminary results of microfacies analysis of the Givetian sediments from the carbonate-sulfate formation in R-1 Vaklino and R-119 Kardam deep wells (Northeastern Bulgaria). This study aims at defining the main microfacies types (MF), characterizing different zones of the ancient sabkha and comparing them with a classical microfacies scheme of Wilson (1975), expanded by Flügel (2004).

Microfacies description

Microfacies type 1 (MF 1) is characterized by wackestones/packstones and packstones with abundant palaeosiphonoclad green algae. The latter are relatively well preserved and are presented within micritic/microsparitic matrix. Rare gastropods, ostracods, bivalves and scarce crinoids also occur. The microfacies could be compared with Standard Microfacies Type SMF 18 "Bioclastic grainstones and packstones with abundant benthic foraminifera or calcareous green algae" (Wilson, 1975; Flügel, 2004). Microfaces type 2 (MF 2) consists of mudstones and wackestones with well-preserved thin-shelled bivalves and whole gastropods, but palaeosiphonoclad algae, ostracods as well as sporadic crinoids and echinoid spines are also locally observed. The micritic/microsparitic matrix contains thin-shelled detritus and often has dark brown or reddish brown appearance, due to non-carbonate admixtures (clay, ferric oxides, etc.). This microfacies is similar to SMF 8 "Wackestones and floatstones with whole fossils and well preserved infauna and epifauna". Packstone/grainstone and grainstone textures are indicative of microfacies type 3 (MF 3). Allochems include peloids and variably presented micritic intraclasts, ostracods, calcispheres, palaeosiphonoclad algae and gastropods scattered within sparite or mixed micrite/sparite groundmass. This microfacies is similar to SMF 16 (non-laminated) "Non-laminated peloidal grainstone and packstone". Microfacies type 4 (MF 4) is presented by laminated peloidal microbial bindstones composed predominantly of small-sized microbial peloids, forming packstone and grainstone textures. Trapped ostracods, calcispheres, rounded and sorted peloids and intraclasts with clotted microfabric locally build up coarser agglutinated laminae. The microfacies could be compared with SMF 16 (laminated) "Laminated peloidal bindstone". Microfacies type 5 (MF 5) is characterized by laminated stroma-

tolitic bindstones, consisting of fine-grained carbonate (micrite or dolomicrite) laminae with clotted microfabric. Some poorly preserved tube-like structures scarcely occur, representing possible calcified cyanobacterial sheaths. Scarce fenestrae filled with calcispar, dolospar or anhydrite correspond to birdseyes type. Microfacies 5 is similar to SMF 20 "Laminated stromatolitic bindstones/mudstones". Microfacies type 6 (MF 6) is composed of densely laminated microbial bindstones. Millimeter-thick laminae are distinguished by fine-grained (micrite/microsparite or dolomicrite/dolomicrosparite) composition. Sporadic small peloids or trapped calcispheres rarely built up coarser laminae. Evaporate minerals (anhydrite and gypsum) or microscale desiccation cracks locally occur. This microfacies corresponds to SMF 19 "Densely laminated bindstone". Microfacies type 7 (MF 7) consists of lithoclastic floatstones/rudstones. The latter are built up of poorly sorted, variable in size angular to subangular lithoclasts of microbial bindstones (MF 4 — MF 6) and mudstones (MF 8), exhibiting sporadic desiccation cracks. The microfacies could be compared with SMF 24 "Lithoclastic floatstones, rudstones and breccias". Microfacies type 8 (MF 8) is characterized by unfossiliferous mudstones, composed of homogeneous dolomicrite/dolomicrosparite or micrite/microsparites. Authigenic evaporate minerals (anhydrite and gypsum) scattered in carbonate matrix are commonly observed. Microfacies 8 corresponds to SMF 23 "Non-laminated homogeneous mudstones without fossils". Microfacies type 9 (MF 9) distinguishes by the presence of anhydrites associating with fine-crystalline dolostones. Evaporates are characterized by variety of early diagenetic structures, including nodular, mosaic "chicken-wire" and enterolitic folds. In thin-sections blocky, lath-shape, microcrystalline, felted, semifelted and align-felted anhydrite textures are recognized. Anhydrite is presented as dominating groundmass or often alternates with dark brown dolomicrite laminae (1–5 mm thick) with homogeneous or clotted fabric. This microfacies is similar to SMF 25 "Laminated evaporate-carbonate mudstone".

Microfacies interpretation

Microfacies types 1–3 characterize shallow subtidal zone of an ancient tidal flat. The fauna association, relatively good fossil preservation as well as micritic/microsparitic matrix of MF 1 and MF 2 evidence to deposition in a calm shallow water environment. The locally importance of high wave activity within subtidal zone (during storms or stronger currents) is suggested from winnowed textures and the presence of micritic intraclasts in MF 3. Microfacies types 4–6 represent former microbial mats developed in intertidal zone by seasonal microbial growth and periodically trapping of sediment material. MF 5 and MF 6 probably characterize mats with smooth morphology, which trapped and bound only little amount of very fine sediment material, whereas MF 4 indicates irregular mat surface, facilitating the trapping and binding of coarser grains (ostracods, calcispheres as well as redeposited peloids and intraclasts, derived through mechanical reworking of the mats) (cf. Riding, 2000). On the other hand, the locally observed desiccation features and scarce evaporate minerals indicate harsh environmental conditions (elevate salinity and periods of subaeral exsposure) of the intertidal zone. MF 7 represents intraformational breccia, composed of lithoclasts originated from desiccation and disintegration of intertidal and supratidal sediments. This microfacies is interpreted as lag deposits in tidal-channels or on the intertidal flat area. The lack of fossils, fine carbonate crystal size and presence of authigenic evaporate minerals suggest that MF 8 was deposited in a highly restricted setting of upper intertidal-supratidal zone. The presence of evaporates (MF 9) with characteristic early diagenetic structures and common dolomicritic laminae (sometimes microbial induced) indicate the supratidal sabkha facies (cf. Warren, Kendall, 1985).

Conclusion

Nine microfacies types (MF 1 — MF 9) have been defined in the Givetian carbonate-sulphate formation in R-1 Vaklino and R-119 Kardam wells (Northeastern Bulgaria) and have been compared with Standard Microfacies Types (Wilson, 1975; Flügel, 2004). They characterize different zones of a typical peritidal (sabkha) succession represented by well-distinguished shallow subtidal sediments (MF 1 — 3), intertidal laminated microbial mats and intraformational breccias (MF 4 — 7) and supratidal carbonates and evaporates (MF 8 and MF 9).

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