Morphological characteristics of the aragonite into the Holocene laminated sapropel (Unit 2) from NW Black Sea Continental Slope

Морфоложка характеристика на арагонита в холоценския ламиниран сапропел (единица 2) от СЗ Черноморски континентален склон

Elena Koleva-Rekalova[1], Krasimira Slavova[2], Ivan Genov[2]
Елена Колева-Рекалова[1], Красимира Славова[2], Иван Генов[2]

[1] Geological Institute, Bulgarian Academy of Sciences, Acad. G. Bonchev str., bl. 24, 1113 Sofia;
E-mail: e_koleva@geology.bas.bg
[2] Institute of Oceanology, Bulgarian Academy of Sciences, 40 First May str., P.O. Box 152, 9000 Varna;
E-mails: slavova@io-bas.bg; idgenov@io-bas.bg

Keywords: aragonite, sapropel, Holocene, NW Black Sea Continental Slope.

Introduction

The aragonite is an unstable polymorph modification of the calcium carbonate. It is formed under a much narrower range of physico-chemical conditions and easily transforms into low-magnesium calcite. For that reason each aragonite finding in the sedimentary record (especially in sapropel levels) causes interest and led to reveal aragonite crystal morphology as well as to creation of hypotheses about its formation and preservation.

The main aim of the present study is to characterize sizes and shape of the aragonite crystals, composing some white aragonite-rich laminae in sapropel of the Holocene Unit 2 (defined by Ross and Degens, 1974) from NW Black Sea Continental Slope. In addition, an attempt is made to relate crystal morphology with possible ways of formation and transportation of the aragonite to the accumulation places.

Material and methods

Five aragonite laminae (with thickness <1 mm) were studied. The material came from the gravity core EuxRo03-3 collected by a GeoEcomar team during a scientific cruise on board R/V Mare Nigrum from the Romanian locations of the MARINEGEOHAZARD project observations. The core is located on the Romanian Black Sea Continental Slope in front of the Danube Delta (Genov et al., 2014). The laminae were found at the base of sapropel (the Holocene Unit 2). The aragonite sizes and shape were determined in 6 smear slides and microphotographed using light microscope “Zeiss Axioscope 40” with built-in digital photo-camera.

Results

Microscopical observations reveal that all studied aragonite laminae from core EuxRo03-3 have the same composition. They are composed predominantly of aragonite rice-like crystals (grains) and spheroidal aggregates (spherulites). The crystal lengths are commonly around and under 0.02 mm (sporadically reaching a maximum of 0.04 mm) and their widths are insignificant – less than 0.004 mm. The spheroidal aggregates possess a pronounced centre and clusters of fibrous crystals that radiate out from the centre. The spherulite sizes are rarely larger than 0.02×0.02 mm. The aggregates are usually crushed to different degrees: from larger particles displaying a fan-like shape to smaller sized fragments having lengths less than 0.01 mm. In smear slides single diatoms and/or debris of them and sporadic angular pyroclastic grains are distinguished, while coccoliths are not observed.

Discussion and conclusions

Usually, aragonite crystals possess needle-like morphology. Ross and Degens (1974) first described rice-like aragonite crystals (grains) near the base of laminated sapropel of the Unit 2 of the Black Sea Basin. Georgiev (1984) also explored aragonite with rice-like, fan-like and spheroidal shapes of the same unit. The aragonite was proven by SEM analyses and some hypotheses about its homogenous (inorganical) precipitation were discussed. Principally, Thomson et al. (2004) when studied sapropel S1 of the Eastern Mediterranean Basin, indicated three main ways for the aragonite formation: production in surface waters (inorganical precipitation), detrital origin (additional

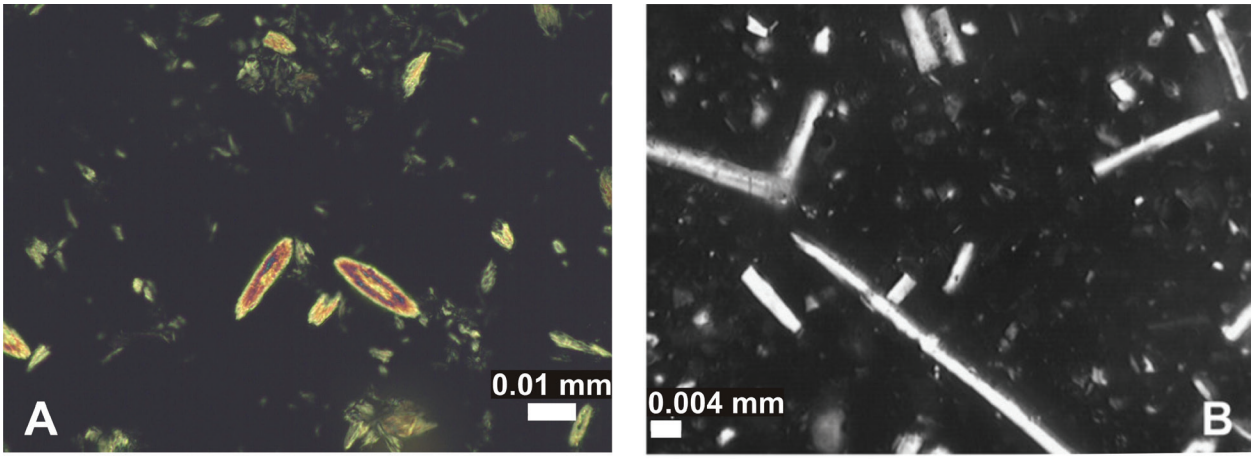

Fig. 1. Petrographic polarizing microscope microphotographs of the smear slides. *A*, aragonite rice-like crystals from core EuxRo03-3 (cross-polarized light); *B*, acicular carbonate crystals (after Oaie, Melinte-Dobrinescu, 2012 – Fig. 6B) (cross-polarized light)

transportation) and diagenetic model. The authors accepted that aragonite in the sapropel S1 was formed as a consequence of sulphate reduction during sediment diagenesis. Reitz and Lange (2006) rejected diagenetic origin and proved that aragonite in the eastern Mediterranean sapropel S1 was transported and redeposited to the accumulation places.

As mentioned in the result the white laminae at the base of sapropel (Unit 2) of the NW Black Sea Continental Slope are composed mostly of rice-like aragonite crystals, predominantly with lengths around and under 0.02 mm (Fig. 1A). Acicular (needle-like) carbonate crystals (Fig. 1B) with length around 10–50 μm (0.1–0.05 mm) were described in the "Shallow Unit" of the Romanian shelf (Oaie, Melinte-Dobrinescu, 2012). When comparing the two types of aragonite it can be seen that the acicular crystals of the shelf are larger than rounded rice-like grains of the continental slope.

The occurrence of laminae composed of aragonite at the base of sapropel may be tied to the Early Holocene Black Sea regressive-transgressive event, defined by Genov et al. (2014). During the regressive period favourable conditions for an inorganical precipitation of needle-like aragonite on the shallow shelf in aridic climate were created. The subsequent abrupt transgression as a result of the invasion of the Mediterranean salt water (Genov et al., 2014) caused erosion of the shelf unconsolidated or poor-consolidated sediments. As a consequence a part of the aragonite sediments were transported from the shelf to the continental slope by gravity flows. Most probably during this redeposition the aragonite crystals acquired smaller sizes and more rounded (rice-like) form by frictional processes. The preservation of the aragonite shows that when aragonite was transported and formed laminae an anoxic condition of the water column in the Black Sea Basin already had existed there.

In conclusion it can be noted that the aragonite laminae at the base of the Holocene sapropel (Unit 2) from NW Black Sea Continental Slope were formed as a result of additional transportation (i.e., redepositional model). The determination of the aragonite morphology contributed to this conclusion.

References

Genov, I., K. Slavova, P. Ivanov, N. Dobrev. 2014. Lithological features of the core EUXRo03-3 and Black Sea geological setting reconstruction. – *C. R. Acad. Bulg. Sci.*, *67*, 1539–1546.

Georgiev, V. M. 1984. Carbonate accumulation on the continental slope in the south-western part of the Black Sea during the Quaternary. – *Rev. Bulg. Geol. Soc*., *2*, 45, 143–160 (in Russian with an English abstract).

Oaie, G., M. C. Melinte-Dobrinescu. 2012. Holocene litho- and biostratigraphy of the NW Black Sea (Romanian shelf). – *Quat. Int.*, *261*, 146–155.

Reitz, A., G. J. de Lange. 2006. Abundant Sr-rich aragonite in eastern Mediterranean sapropel S1: Diagenetic vs. detrital/biogenic origin. – *Palaeogeogr., Palaeoclimatol., Palaeoecol.*, *235*, 135–148.

Ross, D. A., E. T. Degens. 1974. Recent sediments of Blacκ Sea. – In: Degens, E. T., D. A. Ross (Eds.). *The Black Sea – Geology, Chemistry, and Biology*. Am. Assos. Petr. Geol. Mem., 20, 183–199.

Thomson, J., D. Crudeli, G. J. de Lange, C. P. Slomp, E. Erba, C. Corselli, S. E. Calvert. 2004. *Florisphaera profunda* and the origin and diagenesis of carbonate phases in eastern Mediterranean sapropel units. – *Paleoceanography*, *19*, 1–19.