ACTA PALEONTOLOGICA ROMANIAE V. 3 (2001), P. 359-363

FLUID INCLUSIONS IN BADENIAN LIMESTONES FROM NORTH MOLDAVIAN PLATFORM

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Abstract. In this work, some preliminary data concerning the fluid inclusions in limestones from the Grumazu Hill, Ivăncăuți village (Botoşani), are presented.
These limestones, having lumachelle aspect, contain sporadic remainders of bivalves, especially from the *Lucinidae* family (*Lucinoma borealis* Linné) with the valves wholly substituted for SiO_2. In their inside there are transparent quartz microgeodes with liquid inclusions. In the limestones deposits, among shells are present magmatic (with glassy inclusions) metamorphic (with water-carbon dioxide fluid inclusions) and hydrothermal (with monophasic and biphasic fluid inclusions) quartz grain.
This work contributes to the elucidation of the paleoclimatic and paleothermic aspects from the sedimentary and diagenetic Badenian systems.

Keywords: Fluid inclusions, *Lucinidae*, Magmatic, Metamorphic, Hydrothermal, Quartz grains.

INTRODUCTION

The present paper refers to some data concerning the fluid inclusions in Badenian limestones with foraminifers which overstand the micritic limestones, pierced by celestine cracks and small veins from the Grumazu Hill, Ivăncăuți village (Botoşani).

The lithostratigraphical column of Badenian formations from Grumazu, after I. Simionescu (1902), with some completions, is reproduced in Figure 1 (Pomârleanu et. al., 1992). At the lower part, there is gypsum, which reaches 20m in thickness after the drilling data (1).

In the lithostratigraphical succession, on the gypsum formation overstands a brown-yellowish compact limestone stratum, with a variable thickness among 50-90cm. This limestone consists in a fine mass of calcite grains and celestine crystals, which allows its position as micritic limestones with celestine, that we named "celestiniferous horizon" (Pomârleanu, Imreh, 1993). The crystalinity of calcite grains and celestine crystals, the lack of xenogen material fragments and its direct overstanding on the gypsum stratum, shows that this rock was born by direct precipitation of calcium carbonate and strontium sulphate in a calm sequence of water evaporation in a Badenian shallow basin. The global analysis from this rock showed different contents between 1,57% and 12% SrO_2 (Pomârleanu, Imreh, 1993).

Over the "celestiniferous horizon" stand some thin marl intercalations (3), followed by limestones with foraminifers (4), which form the real issue of this paper. These grey-yellowish

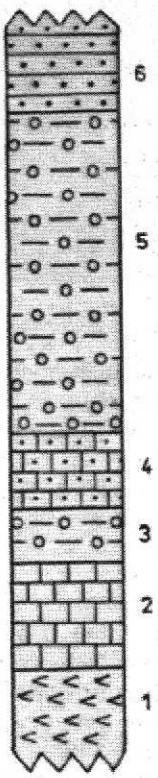

Figure 1

limestones contain plenty foraminifers, especially *Miliollidae*, standing out forms of *Triloculinidae* and *Quinqueloculinidae*.

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Foraminifers are also rarely accompanied by lamellibranchiate shells, especially remainders of *Lucinidae* family, among these stands *Lucinoma borealis* (Linné). The shell valves walls of this species are almost entirely substituted by compact quartz microcrystals (Plate I, Figure 1). Sometimes, inside the shells there are prismatic quartz crystals microgeodes. These crystals have the surfaces well developed in shapes of prism m (1010), direct rhombohedra (1011) and reverse (0111), as it is showed in Figure 2.

The quartz crystals' presence, with well developed shapes, in some lamellibranchiate shells, similar to those from the hydrothermal stage, represents a special occasion of co-operation between crystalographs and palaeontologists, sustaining the possibility of individual quartz formation in the sedimentary and diagenetic cycle process for sediments (Goldstein, 2001).

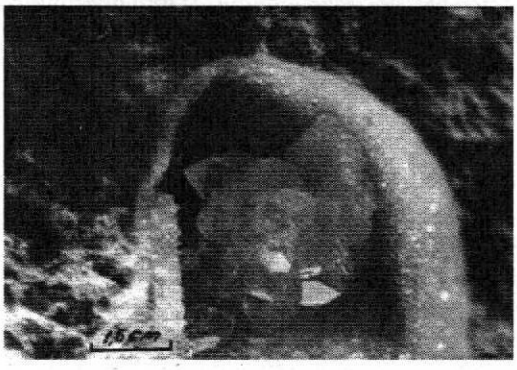

Figure 2

The quartz crystals in microgeodes are rich in monophasic fluid inclusions, which confirm their formation in marine solutions at temperatures below 40°C.

In SiO_2 rich solutions penetration stage, inside the shells, before the formation of real microquartz microgeodes, the pre-existing quartz microfragments from the limestones' mass with foraminifera had been also reworked. These preserve the angular original configuration, uncoroded by calcite (Figure 2).

Similarly, in Transylvanian Basin, inside some shells from Eocene and Oligocene limestones, there have been described quartz crystals, besides baritine, dolomite and even galena (Imreh, Ghiurcă, 1967; Imreh, Imreh, 1961). At this moment, the authors notice the Si, Ba, Pb migration importance in sedimentogenic cycle, concerning the real minerals formation which has an important scientific significance, for the palaeontologists and mineralogists, as for the geochemists.

Besides the first problem, briefly discussed in the paper, referring to quartz microgeodes presence inside some lamellibranchiate shells, the second problem refers to the presence of detritic quartz fragments in the limestones with foraminifers.

The quartz fragments are angular, irregular and homogenous distributed in the rock mass, which proves their origin from the border areas and that they had been carried by some basin waters for a long period of time in Badenian.

Based on the fluid inclusions, detritic quartz fragments prove a mixed origin of the pre-existing magmatic, metamorphic, hydrothermal quartz, as for the colloidal quartz.

The magmatic quartz identification had been proved by the presence of glassy primary monophasic inclusions (Plate I, Figure 2 and Figure 3) and glassy biphasic ones consisting in glass and submicroscopic gas bubbles (Plate I, Figure 4). Based on the contained fluid inclusions, it is proved its formation at temperatures above 1200°C.

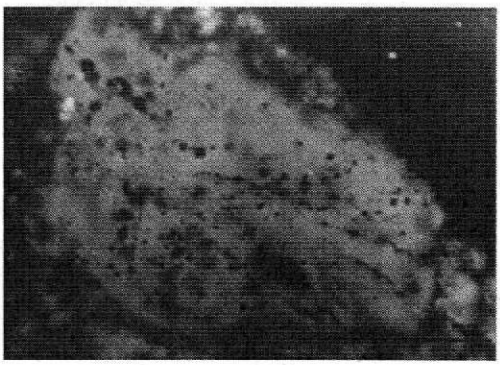

Figure 3

The metamorphic quartz fragments, strongly eroded and replaced by calcite include dioxide carbonic gassy monophasic fluid inclusions (Plate I, Figure 5). Sometimes, these are crossed by planes with watery liquid biphasic fluid inclusions (Figure 3).

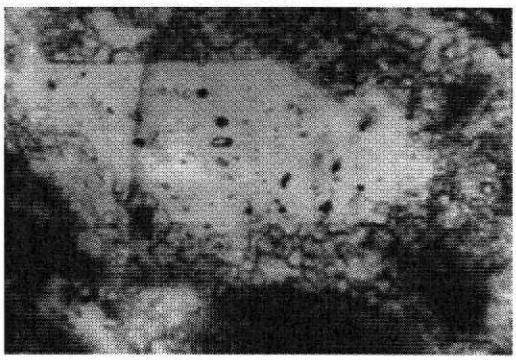

Figure 4

Hydrothermal quartz, as along prismatic shaped crystals with prism and rhombohedra

surfaces, strongly corroded and substituted by calcite aggregates, contains watery liquid primary biphasic inclusions and liquid monophasic ones (Figure 4). Based on the geothermometral data, it was formed between 180°C and 200°C.

Colloidal quartz rarely appears around some foraminifers.

The problem that should be solved is establishing of the origin place of these quartz types that are related to the effusive magmatic, metamorphic rocks, and hydrothermal mineral ores.

CONCLUSIONS

Badenian limestones generally stand out by the presence of *Miliollidae*, pointing out the *Triloculinidae* and *Quinqueloculinidae* families.

The quartz crystals inside some lamellibranchiate shells of *Lucinoma borealis* (Linné) with well developed crystallographic shapes contain monophasic fluid inclusions which prove their formation in marine solutions at temperatures below 40°C.

The presence of this crystal type represents a special occasion of co-operation between crystalographs and palaeontologists, in order to clarify the formation of some minerals in the sedimentogenetic and diagenetic process of sediments.

In Badenian limestones, concerning the origin and the provenience of detritic quartz fragments, there was established their magmatic, metamorphic and hydrothermal nature. Based on these reasons, there should be done particular researches concerning the stratigraphical, paleontological, mineralogical, geochemical and geothermometral aspects, concerning the establish of age and paleoclimat in stratigraphical units, sustaining the postulate that fluid inclusions are "digital prints" in order to identify the origin of quartz detritic fragments in the limestones' mass with foraminifers.

If the palynological metamorphites field has successively searched the microfloristic content in different metamorphic (sedimentary) formations (L. Olaru - oral communication), than the fluid inclusions field explain the process of sedimentary and diagenetic cycle of sediments (Goldstein, 2001).

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FIGURE EXPLANATIONS

Figure 1 The lithostratigraphical column of Upper Badenian with the lithological units from Grumazu Hill: 1-ghips, 2-limestones ("celestiniferous horizon"), 4-limestones with foraminifera; 5-marl with *Lithotamnium*; 6-marl with *Pectinide* (after Simionescu-1902, with some completions).
Figure 2 Geode with quartz crystals inside a *Lucinoma borealis* (Linné) shell.
Figure 3 Fluid inclusions with plane crossings in a metamorphic quartz fragment.
Figure 4 Monophasic (watery) and biphasic (liquid + gas) fluid inclusions in a hydrothermal crystal.

PLATE I

Figure 1 Lamellibranchiate shells, *Lucinidae sp.*, entirely substituted by quartz.
Figure 2, Figure 3 Glassy monophasic fluid inclusions in magmatic quartz fragment in limestones with foraminifera
Figure 4 Glassy biphasic inclusions (glass + air bubble) in magmatic quartz fragment.
Figure 5 Dioxide carbonated monophasic fluid inclusions in a metamorphic quartz fragment.

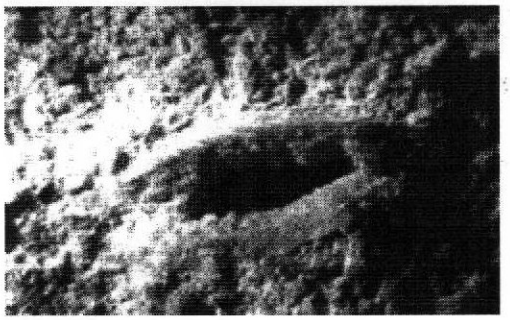

Figure 1

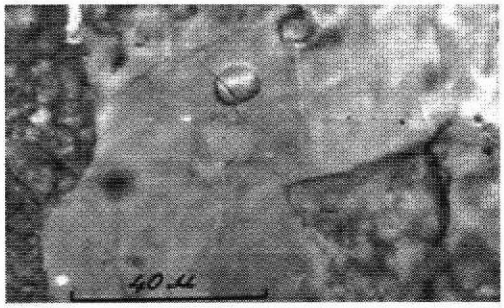

Figure 2

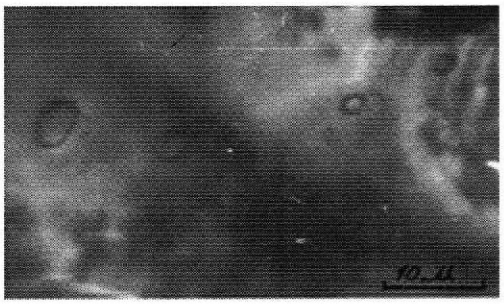

Figure 3

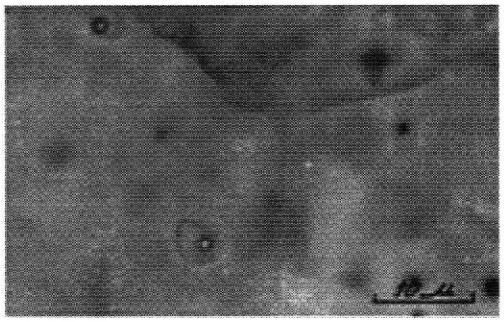

Figure 4

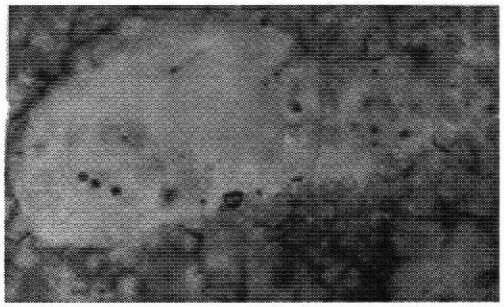

Figure 5