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Sustainable Geological Insights from the Petrographical Study of Jurassic Limestone Cores in the Caragele Structure (Buzău County, Romania)

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ABSTRACT:
The Jurassic formation, west of Capidava-Ovidiu fault, to the north-eastern part of the Moesian Platform, is known relatively little from a petrographic standpoint, an impediment being the insufficient sampling of rock probes. This area of the platform is tectonically active and is part of the Vrancea Seismic Zone, the reason for which numerous studies focused on this aspect rather than other details. The Moesian Platform has long been studied for its hydrocarbon potential, but this feature is in the western part and in isolated areas belonging to the center. The eastern sector, and north-eastern part where our study is conducted, have not been studied in depth due to their correspondence with the Central Dobrogean formations of the same age, for which various studies have been conducted. Our findings reveal the presence of bioturbations during sedimentations which had as result a slight increase in clay material and organic matter in the initial deposits. Also, simultaneously with the recrystallized carbonate as microsparite, small quantities of detrital siliciclastic, somewhat coarser, carbonates have sedimented which resulted in formation of porous space.

Keywords: Eastern Moesia, microsparitic carbonate, bioturbations, crystalline limestone, porous lenticles

1. Introduction

Geographically, the structure is located approximately 32 km south-east from the city of Buzau (Mandruţ, 2021). According to Balintoni (1997), Caragele structure would be part of the Easter Moesian Platform, as can be observed in fig.1, the latter along with the Central Dobrogean Shield forming the Euxinic Craton (Baltolini & Balica, 2016). Sandulescu (1984) and (Barbu 1973) present the Moesian Platform being divided into two blocks by the Intra-Moesian Fault which is currently active since the Cretaceous. Four sedimentary cycles (Mutihac et al., 2007), (Paraschiv, 1979) and (Ionesi, 1994) are specific for our target rock being part of the Liassic (Mid-Jurassic) to Cretaceous. In all sectors of the Moesic platform the sedimentary sequence begins with Ordovician, except for some isolated areas where Cambrian is recorded (Murgeanu&Patrulius, 1960), (Grigoras et al., 1963), (Paraschiv, 1975, 1983) and (Iordan, 1981). The sedimentation continues all the way to the upper Cenozoic. (Pătruț et al, 1983), (Vinogradov, 1978) and (Visarion&Sandulescu, 1979).

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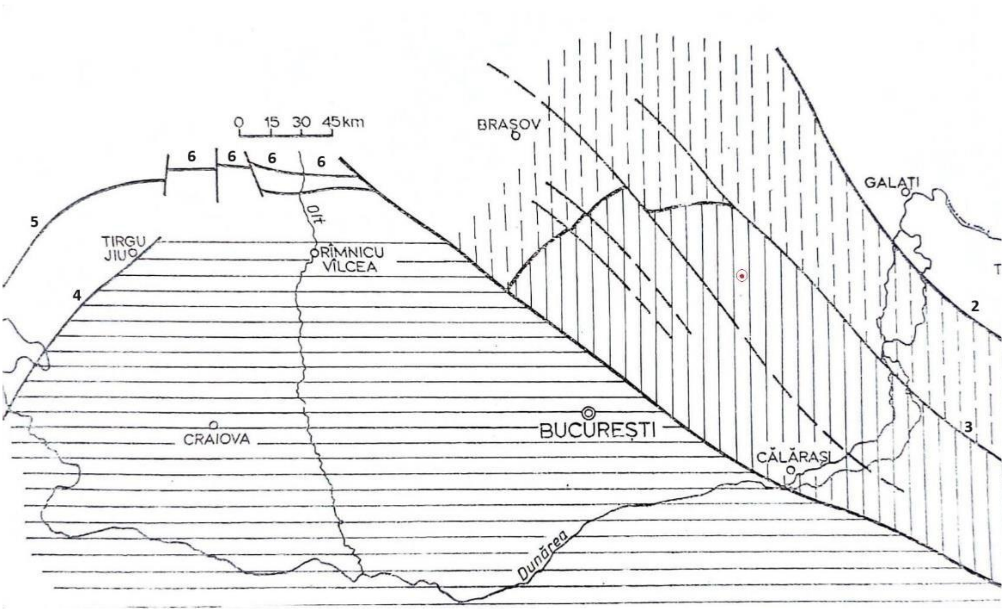


Fig. 1 Main areas of the Moesian Platform: (Vertical lines) Indicating the Dobrogea area and (Horizontal lines) Indicating the Valah area. The red dot within the circle indicates the location of the studied formation. (adaptation from Sandulescu 1984)
1-Intra-Moesian fault 2- Peceneaga-Camena fault 3-Capidava-Ovidiu fault 4-Jiu fault 5- Motru fault (links with Timok fault) 6- Cerna fracture

A particularly important aspect in studying lithology is through correlations of the formations with the ones from Dobrogea area, which has significantly more lithological and petrographical studies, eastern Moesia lacking drilling wells and currently undergoing research. Although central Dobrogea and East Moesian Platform are divided by crustal faults, important tectonic delimitations would have as result differences in subsidence and uplift, Dobrogea witnessed orogenic phases whereas East Moesia post-orogenic faulting (Diaconescu et al., 2019). This localized tectonic activity led to increased thickness, facies variations, unconformities and sudden lithological changes, which are not present in Dobrogea region (Stelea, n.d.) thus implying heterogeneity for the study area. Considering the active tectonic movements, lateral facies changes (Stanciu&Ioane, 2021) would represent the primary uncertatiny in extrapolating information between the two zones. Saulea (1967) supports the idea that Malm (upper Jurassic) debuted in this region and is well-developed, based more on fossil correlations, and molds on the old relief of the green schist formations above being situated transgressively and in unconformity marls and microconglomerates followed by limestones. Vinogradov et al. (1978) describes detrital depositions in the beginning of the sedimentation that continues to be carbonatic until the early-cretaceous. Costea et al. (1978) describes the entire third cycle of sedimentation as having great lithofacies variations with isochrone changes. The Jurassic-Cretaceous formations, when compared especially to Paleozoic and regarding the Permian-Triassic ones, stand out through smaller thicknesses, mainly because of the sedimentation environment (pelagic) as well as, locally, evaporitic as stated by Patrulius (1971).

With a high interest in hydrocarbon research, the western part of the Moesian Platform has been extensively studied (Beca&Prodan, 1983), (Mutihac&Ionesi, 1973), while the eastern side, tectonically active, has been studied from this approach (Coltoi et al., 2016), (Bocin et al., 2005) the focus being set on the Vrancea seismic zone. Our paper brings knowledge of the petrographical features of the Jurassic for an area west of the Capidava-Ovidiu fault that has been mainly researched by correspondence to the central Dobrogea or the green schist zone (fig. 1). Most of the Mesozoic limestones are allochemic made up by carbonate allochems also called grains of the carbonate rock (eg. bioclasts, biomorphs, ooids or peloids) and a cement which can be either micrite or sparite. Limestones which lack allochems are rare and not necessarily homogenous, altough they are referred to as “homogeneous limestones” in the literature. These “homogeneous limestones” were classified as micritic or sparitic although they often contain both sparitic and micritic domains. The lack of allochems may be due both to their absence in the carbonate sediment acting as precursor to the limestone as well as to the recrystallization processes which can erase the original structure. Complete recrystallization which can totally delete the allochemic structures are generally rare, but such situations can occur in old limestones such as Meosozoic ones or even older.

2. Materials and Methods

The present study is based on two mechanical cores sampled from the Jurassic belonging to the eastern Moesian Platform located in Buzau County corresponding to a depth of around 4200 meters. From each fragment were made two thin sections that were studied in the petrology laboratory of the Geological and Reservoir Engineering Department of the Petroleum-Gas University of Ploieşti using a Steindorff polarizing petrographic microscope equiped with a digital photo camera. On the studied sections, a group of microscopy images was made to reveal representative petrographic aspects.

Microscopic Analysis Findings

In all the four thin sections made, the same type of limestone lacking allochems was encountered. The samples are similar regarding their texture and composition. The overall texture of the carbonate rock is characterized by the presence of a dominant mass of microspar carbonate (calcite). These rock probes are comprised of (i) two types of impure microspar carbonate domains, (ii) siliciclasts – which were identified to be exclusively quart granoclasts, (iii) very rare micritic carbonate domains and particles, (iv) opaque minerals and (v) some porous lenses made up by detrital carbonate of siltic-to-arenitic granulation. Structural elements with column layout that have perpendicular or slightly oblique orientations towards thin microlenses that suggest stratification are difficult to explain features other than biotic (for example diagenetic features), the "burrowing" mechanism being the only plausible explanation. The angulations of these columnar characteristics, although variablie, are usually displayed at angles ranging between 70-90 degrees from the alleged stratification, no other microscopic aspect that would suggest a diagenetic origin being found. This dominant mass of microsparitic carbonate appears to have heterogenous granulations at greater orders of magnification. Thus, to an average degree of magnification (250x), it can be observed that between dominant crystals with apparent sizes of 20-50 μm, larger crystals with apparent dimensions of 80-120μm appear from place to place. Some of these larger crystals have subhedral shapes (fig. 2) while others take anhedral shapes following crystallization in the former pores (fig. 3). The clay content of this mass is reduced. To higher degrees of magnification (600x), the presence of clay minerals can be detected either in small patches (patchy microdomains) or having an intergranular location (fig. 4).

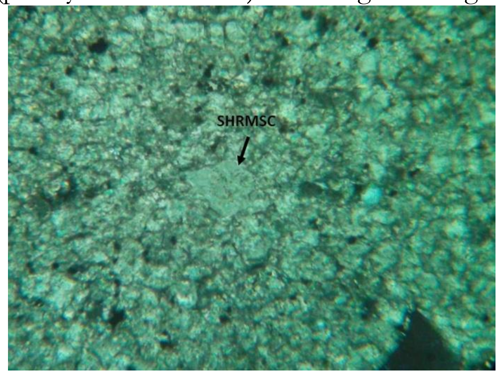


Fig. 2. Heterogenous granulation of microspar carbonate mass: larger crystals and sometimes subhedralare distinguishable from most other crystals (N+,250x) SHRMSC – subhedral rhomboidal microsparite carbonate crystal

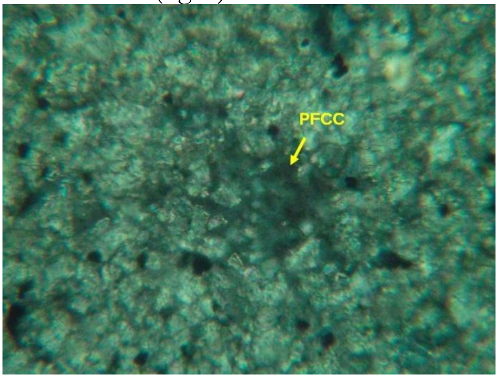


Fig. 3. Late large crystallized anhedral carbonate crystal in the dominant microspar mass of the rock by filling a former pore; the crystal was brought to extinction to highlight the space it occupied(N+250). PFCC – pore filling carbonate crystal

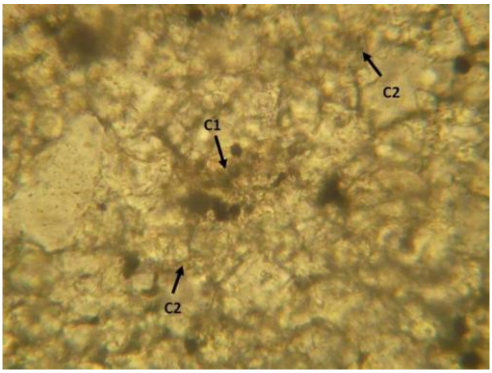


Fig. 4. Clay minerals in the dominant microspar of the rock: they can be located both in distinct areas and are often associated with opaque mineral (C1) as well as in intergranular spaces (C2) (NII 600x)

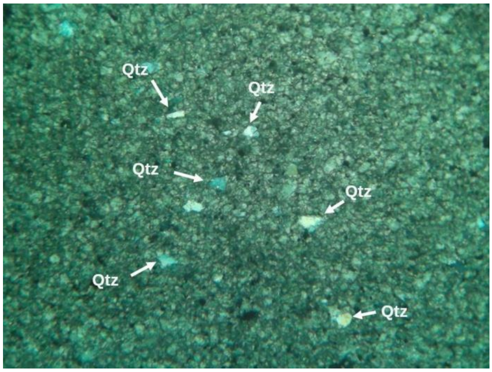


Fig. 5. Quart granoclasts (Qtz) in the dominant microspar mass are: rare, subangular and either siltic or fine arenitic (N+ 100x)

Impure microspar carbonate

The impure microspar carbonate has the same granulations that of the dominant mass but it has a higher content of clay minerals and organic substance. The two types of domains with impure microspar carbonate are:

(i) Lenticular of quasi lenticular microdomains with approximately parallel layout (fig. 6 and 7). These microdomains have apparent thickness between 30 – 70 μm and apparent lengths of the order of 0.6-2.5 mm. They were found in all the analysed sections.

(ii) Elongated microdomains, columnar looking, which have an either oblique arrangement (fig. 8) or perpendicular (fig. 9) with respect to the direction of the microlenses described above. Maximum apparent thickness of these elongated microdomains with columnar aspect are between 0,40 – 0,45 mm. The presence of clay minerals in these domains is easy to see, even in small orders of magnification due to a lower degree of transparency. Elongated microdomains with columnar aspect, of impure carbonate microspar, have occurred only in two of the four thin sections made by us.

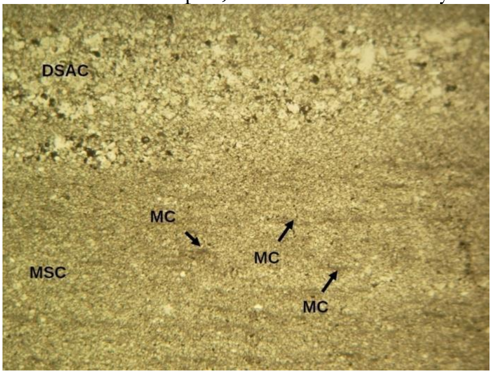


Fig. 6. The overall structure of the carbonate rock: a dominant mass of microspar carbonate (MSC), lacking allochems and with rare siliciclasts include:
a) porous millimetric lenticular microdomains of detrital carbonate with siltic-arenitic granulation (DSAC)
b) impure microsparitic carbonate domains (IMSC) especially in the form of very thin lenses (NII, 30x)

MSC – microsparitic carbonate DSAC – detrital siltic-arenitic carbonate IMSC – impure microsparitic carbonate

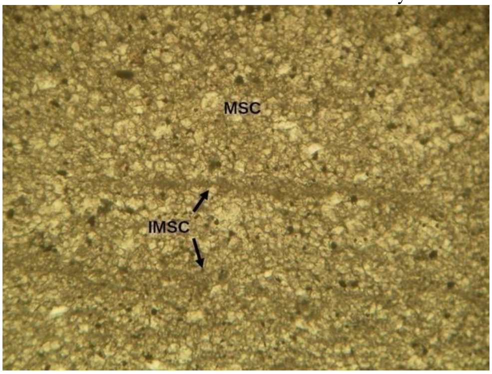


Fig. 7. Detail on two microlenses with impure microsparitic carbonate (IMSC) within the mass of microsparitic carbonate (MSC) (the microlens thickness are of 10-2 mm order and lengths do not exceed 3mm) (NII, 100x)

MSC – microsparitic carbonate
IMSC – impure microsparitic carbonate

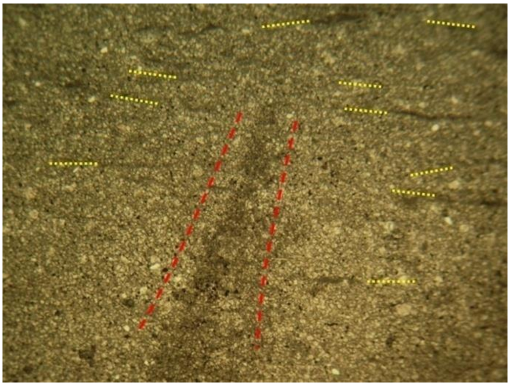


Fig. 8. Impure microsparitic carbonate (IMSC) is also present in the form of domains with elongated forms (with "columnar" aspect) which have an oblique direction to the plans indicated by the microlenticular domains also made up of impure microsparitic carbonate (NII, 40x)

Obs. For a better understanding, the elongated columnar domains are marked with red dotted linesand the planes indicated by the microlenticulardomains are marked with yellow dotted lines

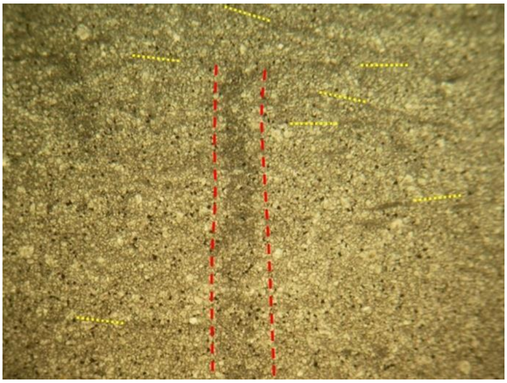


Fig. 9. Impure microsparitic carbonate (IMSC) is present in the form of domains with elongated forms (with "columnar" aspect) which have a direction nearly perpendicular to the microlenses also made up of impure microsparitic carbonate (NII, 40x)

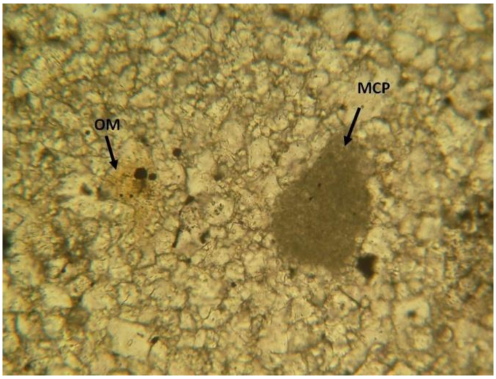
Obs. For a better understanding, the elongated columnar domains are marked with red dotted lines and the planes indicated by the microlenticular domains are marked with yellow dotted lines

Siliciclasts

These components consist exclusively of quart granoclasts. Based on granulation, they belong to silt and fine arenite classes. The majority are monogranular and are angular or subangular (fig. 4). Few of them have been encountered with sub-rounded forms. The total quartz proportion does not exceed 2% of the total rock volume.

Very Rare Micritic Carbonate

As mentioned earlier, the micritic carbonate appears completely subordinate and can be in the form of particles or small domains. Micritic carbonate particles present relatively rounded shapes and apparent maximum dimensions of 170-180μm (fig. 10). They have no peculiar structures to indicate the origin. Most probably, they are intraclasts. Micritic carbonate domains have a high content of clay minerals, show irregular shapes and they have no consistent arrangement with the impure microsparite microlens (fig. 11). The dimensions of these domains are maximum 2-3 mm.



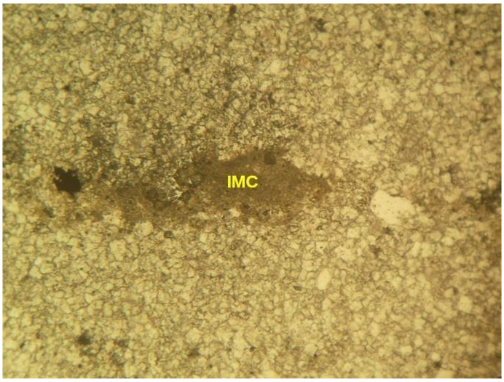


Fig. 10. Micritic carbonate particle (MCP) and organic matter (OM) present in the micritic carbonate mass of the rock (NII, 250x)

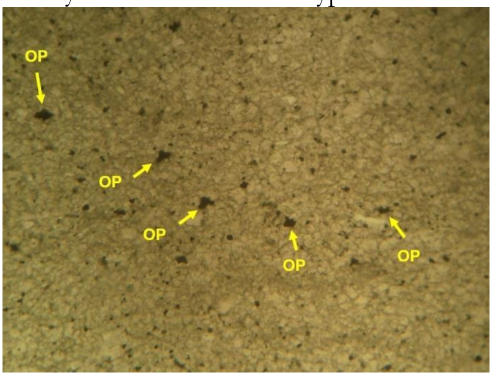
OM – organic matter
MCP – micritic carbonate particle

Fig. 11. Domain comprised of impure micritic carbonate (IMC) in the dominant carbonate microsparitic mass; these types of domains do not present a consistent arrangement with the quasi lenticular micritic domains (NII, 40x)

IMC – impure micritic carbonate

Opaque Minerals

Pyrite is the opaque mineral and appears as isolated crystals or microaggregates. These can be arranged disseminated (fig. 12), in strings with direction approximately oblique to the orientation of the impure microsparit microlenses (fig. 13) or in aggregates with poorly anisometric shapes that appear to be formed by the substitution of former specific microdomains of the rock (fig. 14). Pyrite aggregates with poor anisometric shape having dimensions between 0,4 – 0,7 mm and they include (in the majority of the situatios) carbonate microsparitic crystals. The apparent dimensions of the crystals and aggregates with layout of disseminated type are in the range of 8 – 30 μm.



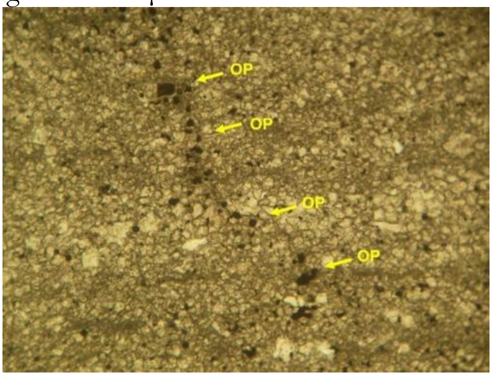


Fig. 12. Opaque particles (OP) in the dominant microsparitic carbonate mass: either crystal, either microaggregate crystals of pyrite (NII, 100x)

Fig. 13. Arrangement of opaque pyrite particles is locally in strings with oblique arrangement to the orientation of the micritic (NII, 100x)

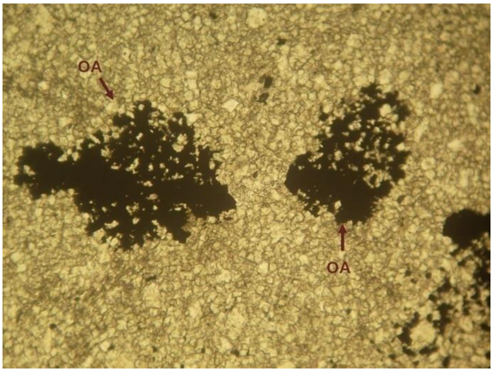


Fig. 14. Grouped pyrite crystals into aggregates (OA), larger, with poor anisometric shapes and which seem to be formed by processes of substitution; sizes of these aggregates are of the order 10-1 mm (NII, 40x)

OA – opaque crystal aggregates

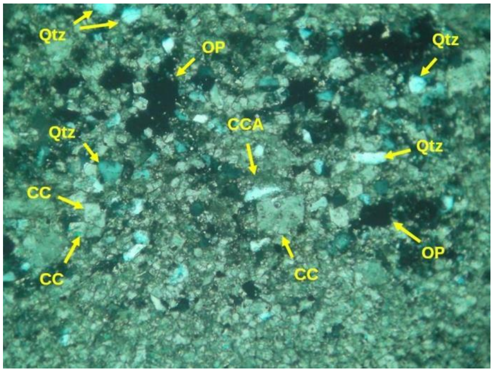


Fig. 15. The structure of a lens comprised of detrital carbonate: besides the carbonate crystals, in these domains there can be found quart granoclasts (Qtz), opaque mineral particles (OP) and clay-carbonate microaggregates (CCA). The proportion of quart particles is the highest compared to the rest of the rock (N+, 100x).

Looking at the porosity, the dominant carbonate microsparitic mass is lacking free pores. However, there are rare small spaces with slightly larger dimensions than those of carbonate crystals in which organic matter is present. (fig. 10).

Porous lenticles made up especially from detrital carbonate

These lenticles (fig. 6) consist of, mainly, detrital carbonate of siltic-arenitic granulation (calcarenite) and subordinately contain quart granoclasts, opaque mineral particles and clay-carbonate microaggregates (fig. 15). Their apparent thickness is between 1,4 to 1,6 mm. The proportion of quart is somewhat greater than in the dominant microsparitic domain. Here, the majority of quart siliciclats are arenitic and slightly coarser than the rest of the rock. The carbonate clasts are mostly monogranular and they have apparent dimensions in the range of 18 to 116 μm. On a small-order magnification examination (40x) these lenses seem to be made up of sparitic carbonate but at average orders of magnification (as 250x) the detrital structure becomes more obvious. Pores are frequent, have an uneven distribution and are interclastic from a genetic point of view. An interesting microstructural observation in these lenticles is the presence of euhedral rhomboedric carbonate crystals and their inclusions of quartz granoclasts (fig. 16).

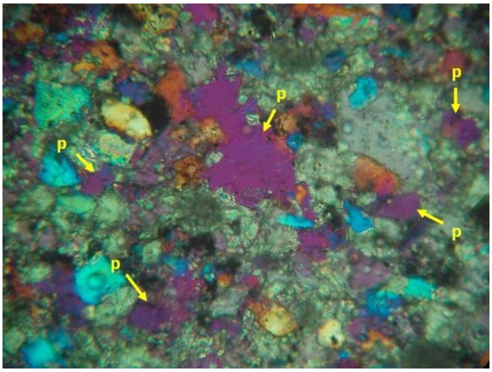


Fig.16. Porous structure of lenses with detrital carbonate; pores (p) are unevenly distributed within the mass of these lenses (N+, 250x)

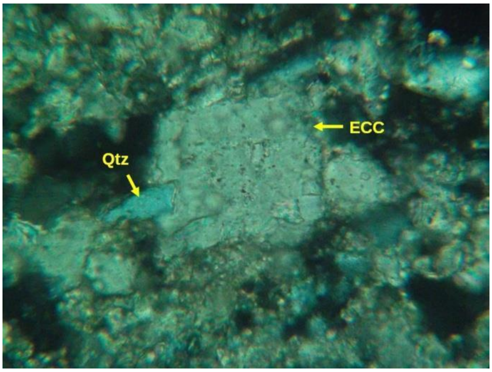


Fig. 17. The relationship of inclusion of quartz clasts by diagenetic sparitic carbonate crystals formed in detritic carbonate lenses

3. Results and interpretations

The dominant carbonate microsparitic mass is the result of carbonate silt recrystallisation in a pelagic domain. Although at present this microsparite is devoid of pores there are petrographic aspects that suggest a former existence of pores until the later stages of diagenesis: presence of carbonate subhedral cystals (fig. 2) and large ones with forms characterized by the presence of extensions in the intergranular spaces of ordinary granulation crystals (fig. 3). Impure domains of microsparitic carbonate are the result of bioturbations of the carbonate mud originally deposited by a bentonitic microfauna. These bioturbations have had as result a small locally increase of clay minerals and organic substance of the carbonate material firstly sedimented.

Bioturbations are of two types: (i) done in parallel with the former water-sediment separation (interface) – which generated the current microlens of impure microsparitic carbonate (fig.6 and fig. 7) and (ii) done in the depth of the sediment - what generated the elongated columnar domains with impure microsparitic carbonate, which have oblique or even almost perpendicular direction related to the the planes corresponding to the microlenses and implicitly to the former water-sediment interface (fig. 8 and fig. 9)

Bioturbations made in the depth of the initial carbonate mud may not have generated all carbonate domains with higher clay content. Some strings of pyrite crystals, like the ones presented in fig. 12, may also have crystallized along some former bioturbation trails deeply in the sediment, correlated with a local increase in local organic matter content. Either concomitantly or alternatively to the carbonate mud sedimentation what is now recrystallized in the form of microsparite, there was a small and local deposition of carbonate – siliciclastic detrital material, somewhat coarser, on account of which porous lenses were formed.

The presence in these microlenses of the euhedral rhomboidal carbonate crystals and especially the fact that some of these crystals partially include quartz granoclasts (fig. 17) reveal that some of the carbonate present here is diagenetic and is formed in the porous space. Although the porosity of these lenticles has decreased, it is still high (> 15% of their total volume) but contributes little to the total porosity of the rock which is extremely low because the detritic carbonate lenticles do not constitute more than 2 - 3% of the total rock volume.

As a mineral component with apparent detrital origin this rock reveals only fine quartz granoclasts without their association with similar sized granoclasts of feldspar or phyllosilicate. Although this might indicate a sorting performed by intrabazinal currents, a sorting performed by wind could not be excluded. However, the pronounced subangular to angular morphology of these small quartz clasts makes it highly unlikely to be transported by wind or water currents. These small quartz clasts can be interpreted rather as pyroclasts- from this perspective other prioclasts deposited simultaneously in the carbonate sediment (vitroclasts and crystalloclasts of feldspar) could have been degraded by diagenetic hydrolysis, contributing to the diagenetic generation of the clay fraction of the rock.

A remarkable feature of this exogenous carbonate rock is the lack of slighter coarser detrital phyllosilicates, such as muscovite and illite. It shows that the siliciclastic particles of quartz originate form a sediment already deposited intrabazinally and remobilized within the sedimentation domain. Probably this sediment has previously undergone a sorting process with the separation of the detrital phyllosilicates.

From a petrographic viewpoint, according to the Dunham (1962) classification, later modified by Embry&Klovan (1971), this rock represents a crystalline limestone having the original texture still partially recognizable. Primary structures can be concluded based on the presence of micro-lenticular structural elements with subparallel arrangement (indicating the direction of stratification) and structural elements of burrowing (expression of bioturbation processes).

4. Conclusions

Many studies have been conducted in the eastern part of Moesian platform due to the very pronounced seismic activity having identified the Vrancea seismic zone. In addition, not many wells for hydrocarbons have been drilled, not only because of reason, but also because the resources are located further west. The data which is available is mostly obtained from correlations with the Central Dobrogea region and is consequence extrapolated. The volume of samples obtained did not allow (although it was tried) to obtain a sufficient volume of insoluble residue to perform a diffraction analysis with X rays. Moreover, the analysis of the organic substance part of this residue would be even lower quantitatively. The action of concentrated hydrochloric acid that completely dissolves carbonate is known to significantly alter any organic molecules present.

The intimate association of the components that give impure character of some micro-domains of this rock with the carbonate part excludes a possible identification of them by a common microscopy technique associated with EDS. The response signal from the sample would come mostly from the carbonate side.A general lithological description of the Jurassic is calcareous rocks which based on our detailed petrographic study would reveal a microsparitic limestone recrystallized in a pelagic domain. This rock was formed by the diagenesis of an initial calcareous mud which was bioturbated soon after deposition, leading to a small increase of clay minerals and organic matter content. Also, during the calcareous mud deposition there were small proportions of slightly coarser carbonate – siliciclastic detrital material deposition which would represent the basepoint of porous spaces that have lenticular shapes. The porosity of the sediment contributes almost insignificantly to the entire rock and would denote in the end a Jurassic buildup of crystalline limestone having an unmodified (at least in part) original aspect. The eastern area of the Moesian platform presents interesting opportunities regarding hydrocarbon resources. Jurassic formations, found at depths of over 4000 m are being explored, data obtained from cores and drill cuttings being very limited. Production tests on wells that were drilled for exploration purposes highlighted gases, but research is ongoing and benefits from the much-improved seismic methods.

References

Balintoni, I. (1997), Geotectonics of Romanian Metamorphic Terrains (in Romanian). Ed. Carpatica, Cluj Napoca, 176 pp

Balintoni I., Balica C. (2016), Peri-Amazonian provenance of the Euxinic Craton components in Dobrogea and of the North Dobrogean Orogen components (Romania): A detrital zircon study, Precambrian Research 278(2016)34–51, http://dx.doi.org/10.1016/j.precamres.2016.03.008, 0301-9268/ 2016 Elsevier

Barbu, C. (1973), The deep structure of the eastern part of the Moesian Platform (Romanian territory) focused on the possible Paleozoic oil and gas accumulations (in Romanian) (Unpublished PhD Thesis). Bucharest University.

Beca C., Prodan D. (1983), Geologia Zacamintelor de Hidrocarburi, Editura Didactica si Pedagogica Bucuresti

Bocin A., Stephenson R., Tryggvason A., Panea I., Mocanu V., Hauser F., Matenco L. (2005) 2.5D seismic velocity modelling in the south-eastern Romanian Carpathians Orogen and its foreland, doi:10.1016/j.tecto.2005.05.045, Tectonophysics 410 273–291, Elsevier

Coltoi O., Nicolas G., Safa P. (2016) The assessment of the hydrocarbon potential and maturity of Silurian intervals from eastern part of Moesian Platform e Romanian sector, Marine and Petroleum Geology 77653-667, http://dx.doi.org/10.1016/j.marpetgeo.2016.06.024, 0264-8172/© Elsevier

Costea I., Comsa D., Vinogradov C., (1978), St. cerc. geol. geofiz. geogr. Geol., 23, 2, p. 299-311, Bucuresti

Diaconescu M., Craiu A., I.A. Moldovan, Constantinescu E.G., Ghita C., (2019), Main Active Faults from Eastern Part of Romania (Dobrogea and Black Sea). Part II: Transversal and Oblique Faults System, Romanian Reports in Physics 71, 708

Dunham, R.J. (1962) Classification of carbonate rocks according to depositional texture. In: Classification of Carbonate Rocks (Ed. W.E. Ham), Am. Assoc. Pet. Geol. Mem., 1, 108– 121

Embry, Ashton F.; Klovan, J. Edward. (1971 December 1) "A late Devonian reef tract on northeastern Banks Island, N.W.T". Bulletin of Canadian Petroleum Geology. 19 (4): 730–781. ISSN 0007- 4802,

Grigoras N., Patrut I., Popescu M., (1963), Asoc. Geol. Carp-Balk., Conngr. V, IV, p. 115- 131, Bucuresti

Ionesi, L., (1994) Geologia Unitatilor de Platforma si a Orogenului Nord-Dobrogean. Editura Tehnica, Bucuresti. 280 pp.

Iordan M., (1981), Mem. Inst. Geol. Geophys. XXX, p. 115-122,Bucuresti

Mândruţ O. (2021), Atlas Geografic Scolar, Editura Corint

Murgeanu G., Patrulius D., (1960), Anal. Publ. Inst. Hung. XLIX, 1. Budapest

Mutihac V., Ionesi L. (1973), Geologia Romaniei, Editura Tehnica, Bucuresti

Mutihac V., Stratulat M.I., Fechet R.M. (2007), Geologia Romaniei (editie revizuita), Editura Didactica si Pedagogica

Paraschiv, D, (1983), An. Inst. Geol. Geofiz., LIX, p. 177-188, Bucuresti

Paraschiv, D.(1979) Platforma Moesica si zacamintele ei de hidrocarburi. Editura Academiei, Bucuresti.

Paraschiv, D., (1975), St. then. Econ., Inst. Geol. Geofiz., A-10, p. 2-363, Bucuresti

Patrulius D. (1971), D. S. Inst. Geol., LVII 5, Bucuresti

Pătruţ I., Paraschiv C., Danet T., Baltes N., Danet N., Motas I., (1983), An. Inst. Geol. Geofiz. LIX, p. 55-62, Bucuresti

Sandulescu, M. (1984) Geotectonics of Romania (in Romanian). Ed.Tehnica Bucuresti, 336 pp.

Saulea, Emilia (1967) Historical Geology (in Romanian), Ed. Didactica si Pedagogica, Bucuresti, p. 426

Stanciu, I., & Ioane, D. (2021). The Moesian Platform: structural and tectonic features interpreted on regional gravity and magnetic data. Geo-Eco-Marina, 27, 183-195. doi:10.5281/zenodo.5795188

Stelea I. (n.d.) Active Tectonic Processes on the Territory of Romania, Geological Institute of Romania

Vinogradov C., (1983), An. Inst. Geol. Geofiz., LIX, p.127-142, Bucuresti

Vinogradov C., Costea I., Comsa D., (1978), St. cerc. Geol. Geofiz., geogr., Geol., 23, 1,p. 65-72, Bucuresti

Visarion M., Sandulescu M. (1979) St. cerc. geol. geofiz. geogr., Geofiz, 17, 2, p. 191-201, Bucuresti