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New sedimentological finding studying the Cretaceous deposits along the new Ionian road around the Amphilochia and Arta sections

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Introduction – Geological setting

Upper Cretaceous–Lower Eocene deposits of the Ionian basin are the major target in hydrocarbon exploration as they represent the reservoir rocks. These deposits mostly are composed of calciturbidites interbedded with breccia-microbreccia deposits. According to Bourli et al., 2019 the studied outcrops from Araxos area (internal Ionian sub-basin) showed that the breccia - microbreccia deposits are structureless, with a channelized geometry and calciturbiditic blocks internally to the channels; whereas most of the clasts were sourced from the underlying Lower Cretaceous "Vigla limestones". Moreover, microfacies analysis indicate deep-water deposits and reworked shelf deposits. The intense extensional tectonic activity in the Ionian basin during the early Cretaceous, with synthetic and antithetic faults, produced active platform margins and asymmetrical grabens. During the late Cretaceous, the uplifted margins of the grabens caused erosion of the pre-existing deposits of the early Cretaceous "Vigla formation".

Analysis of the studied sections – Field work

In order to have a better understanding of Upper Cretaceous-Lower Eocene evolution of the Ionian basin, two new-outcropped sections were selected around Amphilochia – Arta area (middle Ionian sub-basin). Amphilochia section is directed parallel to the thrust faults (NNW-SSE), whereas Arta section is directed parallel to the transfer or strike slip faults (NE-SW).

In the new Ionian road, Amphilochia section, and although geological map showed the presence only of the Upper Cretaceous deposits, in the new sections the lower stratigraphic deposits correspond to the Lower Cretaceous Vigla shales or Vigla limestones, whereas Upper Cretaceous limestones rest unconformably over the Lower Cretaceous sediments. Lower Cretaceous deposits are characterized by strong discontinuity along the NNW direction, that mostly influenced by syn-sedimentary transfer faults. In addition, slumps were observed throughout the sections with E-W direction with a sliding from the east. These slumps are result of an instability probably produced from the N-S directed normal faults (Figure 1a). The dip direction of the beds is NNE-SSW.

In the new Ionian road the Arta section, with a NNE-SSW direction, is strongly deformed due to many reverse faults, probably branches of the major thrust fault, situated west of the studied section. The above deformation is owed to the compressional regime (Eocene to Miocene) that influenced the whole area after the sedimentation. These deformations are recorded in many outcrops along the Ionian road and their general dip is 230°/50° (Figure 1b).

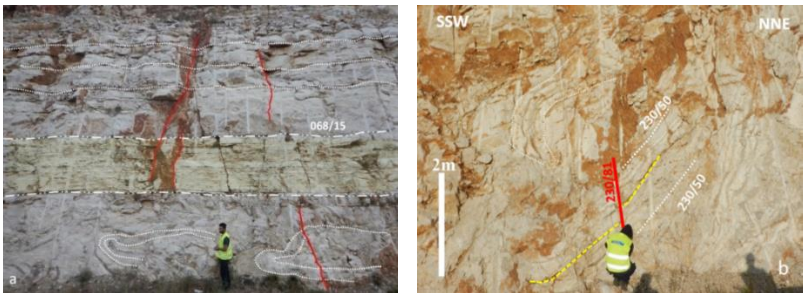

Figure 1: This figure shows: (a) the slumps on the lower stratigraphic layers and the non-deformed sediments above them (Amphilochia section), (b) the intense deformation of the sediments due to reverse faults. The sediments as a result of the deformation have dip and dip direction, respectively, 230°/50° (Arta section).

Microfacies analysis of thin sections

Microfacies analysis carried out in thin sections from selected samples from Amphilochia, Arta and Kerasonas showed that most of the sediments deposits belong to deep marine environment (FZ 1 **&** 2), some of them showed a slope to shelf environment (FZ 3 **&** 4) and only a few showed shallow water environment. The main textural and compositional characteristics, as well as the sedimentary features of the distinguished microfacies are summarized in Table 1, corresponding to different depositional environments or facies zones (FZ: Flügel, 2010). More specifically, the "Vigla limestones" were classified as packstones/wackestones with scattered planktonic foraminifera and radiolarian limestones (standard microfacies SMF 3), indicating a deep-sea basin environment (FZ 1). Upper Cretaceous incudes pelagic wackestones with planktonic foraminifera (SMF3); microbreccia biolithoclastic packstones to grainstones (bioclasts, planktonic and benthic foraminifera (SMF4) indicating slope environment (FZ4) – toe of slope (FZ3), and, allochthonous bioclastic packstone to rudstone/floatstone breccia containing rudist and gastropod fragments, planktonic and benthic foraminifera, geopetal fractures (SMF5) indicating a slope environment (FZ4). Fenestral cavities and geopetal fractures in allochthonous material may indicate a source from a restricted or shallow shelf environment (FZ4) with the influence of meteoric water. The Paleocene pelagic grainstone containing planktonic and benthic foraminifera (SMF2), corresponding to a deep shelf environment (FZ 2) and finally, Eocene pelagic wackestones with planktonic foraminifera (SMF3), indicating a toe of slope environment (FZ3).

Table 1. Detailed description of studied smear slides where depositional facies, lithology, fossils and the age of the studied deposits are presented (SMF= Standard Microfacies Type, FZ= Facies Zone, Pl.z.= Planktonic zone, foraminifera=forams).

No. of Samples	Facies Description	Fossils	Lithology	Stage
Amphil. sec.: 1	Pelagic wackestone with planktonic forams (SMF3). alaeoenvironment: Toe of slope (FZ3)	Planktonic forams (*Subbotina inaequispira, Globorotalia centralis, Morozovella aragonensis*)	Thin-bedded limestones with chert intervals	Eocene - [Lutetian (P1.z. 11a) - Lutetian (P1.z. 11b)]
Arta sec.: 1	Pelagic grainstone with benthic and planktonic forams (SMF2). Palaeoenvironment: Deep shelf (FZ2)	Benthic & planktonic forams (*Acarinina subsphaerica, Morozovella angulata)*	Micro brecciated limestones	Paleocene - [Selandian (Pl.z. 3b)- Thanetian (Pl.z. 5a)]
Amphil. sec.: 2 Arta sec.: 2	Allochthonous bioclastic packstone to rudstone/floatstone breccia. Rudist and gastropod fragments, planktonic and benthic forams, geopetal fractures (SMF5). Palaeoenvironment: Slope (FZ4)	Planktonic forams *(Globotruncana falsostuari, Siderolites calcitrapoides)* & benthic forams *(*Miliolidae, *Orbitoides midea, Cuneolina sp.),* rudist & gastropod fragments, algae	Micro brecciated limestones	Upper Cretaceous – Maastrichtian
Arta sec.: 8, Amphil. sec.: 3, Keras. sec.: 1	Two facies: 1. Pelagic wackestones with planktonic forams (SMF3). 2. Microbreccia biolithoclastic packstones to grainstones. Bioclasts, planktonic and benthic forams (SMF4). Palaeoenvironment: Slope (FZ4) – Toe of slope (FZ3)	1. Benthic and planktonic forams (*Sigalitruncana sigali, Marginotruncana pseudolinneana*) 2. Benthic and planktonic forams (*Globotruncanita stuartiformis,Marginotruncana renzi)*	1. Thin-bedded limestones with chert fragments 2. Micro brecciated limestones	Upper Cretaceous – [Turonian (Pl.z. 1) – Campanian (Pl.z. 2)]
Arta sec.: 10, Amphil. sec.: 5, Keras. sec.: 15	Bioclastic pelagic packstones and wackestones that contain scattered pelagic microfossils. Palaeoenvironment: Deep-sea basin (FZ1)	Radiolarians and planktonic forams (Calpionella sp.)	Vigla limestones and shales	Lower Cretaceous
Amphil. sec.: 4 Keras. sec.: 2	Palaeenvironment: (FZ9) Evaporitic/brackish platform interior – Restricted platform interior (FZ8)	Benthic forams (Miliolidae, Rotalidae) Algae	Pantokrator limestones	Lower Jurassic

Discussion and conclusions

In the Amphilochia new cross-section, with a N-S direction, the lower Cretaceous Vigla limestones and Vigla shales were outcropped for first time. This section is directed parallel to the paleo Ionian basin axis and the fact of the lateral discontinuity of Vigla limestones and Vigla shales indicate that during the sedimentation of these two formations there was a restriction along the paleo basin axis, probably due to synsedimentary transfer fault activity.

In the Arta new cross-section, with a NE-SW direction, the upper Cretaceous Senonian deposits showed strong deformation that took place during the compressional regime that affected the Ionian basin after sedimentation. This deformation is stronger in the western part, close to a major thrust, and seems that this deformation could produce a high secondary porosity increase of upper Cretaceous deposits.

The unconformably overlying Upper Cretaceous Senonian limestones are characterized by micro-breccia, calciturbidites and slumps, as recognized and in other areas (Bourli et al., 2019).

Microfacies analysis showed in general a deep-sea environment with few exceptions with shallow environment character, introducing the existence of platforms, close to the studied sections.

References

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