

TRANSYLVANIDES - A JURASSIC-CRETACEOUS PALEOENVIRONMENTAL AND DEPOSITIONAL MODEL

Ovidiu DRAGASTAN

University of Bucharest, Faculty of Geology and Geophysics, Department of Geology and Paleontology,
Bd. N. Bălcescu, 70 111 Bucharest, Romania

Abstract: Jurassic and Cretaceous litho- and biofacies boundary of the Metaliferi (Metalliferous) Mountains (South-Western) and of the Transylvanian carbonate platform (Turda - Rimetea - Aiudului Gorges and Haghimaş), both Transylvanides were investigated. The evolution of the facies in the Metaliferi Mountains points out the presence of three basins: Bucium, Drocea, Trascău and Mureş carbonate platform separated by two pelagic rises evolved in a calc-alkaline volcanic island arc. The Transylvanides outcropping in the Ampoiţa - Aiudului Gorges, Rimetea-Turda Gorges, was formed by the limestone disposed on the ophiolite sequence. The limestone sequence evolved in a slope-shelf edge (Aiudului-Rimetea area) and an inner shelf facies with island archipelagoes (in Turda area). Haghimaş carbonate area platform with slope and barrier reef facies bilaterally disposed evolved on a seamount, aligned along a rise of the Tethys Realm.

Key words: Jurassic/Cretaceous, litho- and biofacies, paleoenvironmental reconstructions.

1. Introduction

The Transylvanides defined by Săndulescu (1984) included the Metaliferi Mountains and the Transylvanian Nappes, the last one distributed in the East Carpathians as "outliers" in Haghimaş (Hg), Olt (Ot), Perşani (P) (Fig. 1).

During the Late Jurassic-Early Cretaceous, the Metaliferi Mountains evolved in a calc-alkaline volcanic island arc basin.

In the Metaliferi supraunit three sedimentary troughs were separated: Bucium (B), Drocea (D), Trascău (T), also including the Mureş carbonate platform. (Patrului et al., 1976).

The limestone sequences developed like a ridge from south to north, in the Ampoi - Aiudului Gorges, Rimetea and Turda Gorges, also belong to the Central Transylvanian

carbonate platform.

The Haghimaş Mountains, including the Bicaz Gorges, correspond to another "segment" of the Central Transylvanian carbonate platform, more extensive in an open area of the Tethyan Realm.

2. Framework and depositional setting

The evolution of the Metaliferi Mountains during the Late Jurassic and Early Cretaceous was influenced by the intraoceanic subduction movements, when the rising of island arc volcanic calc-alkaline rocks started (Bleahu, 1981, 1989, Savu, 1996) together with the accumulation of sedimentary deposits. A large Transylvanian depositional carbonate platform was formed near the Metaliferi (Metalliferous) Ocean.

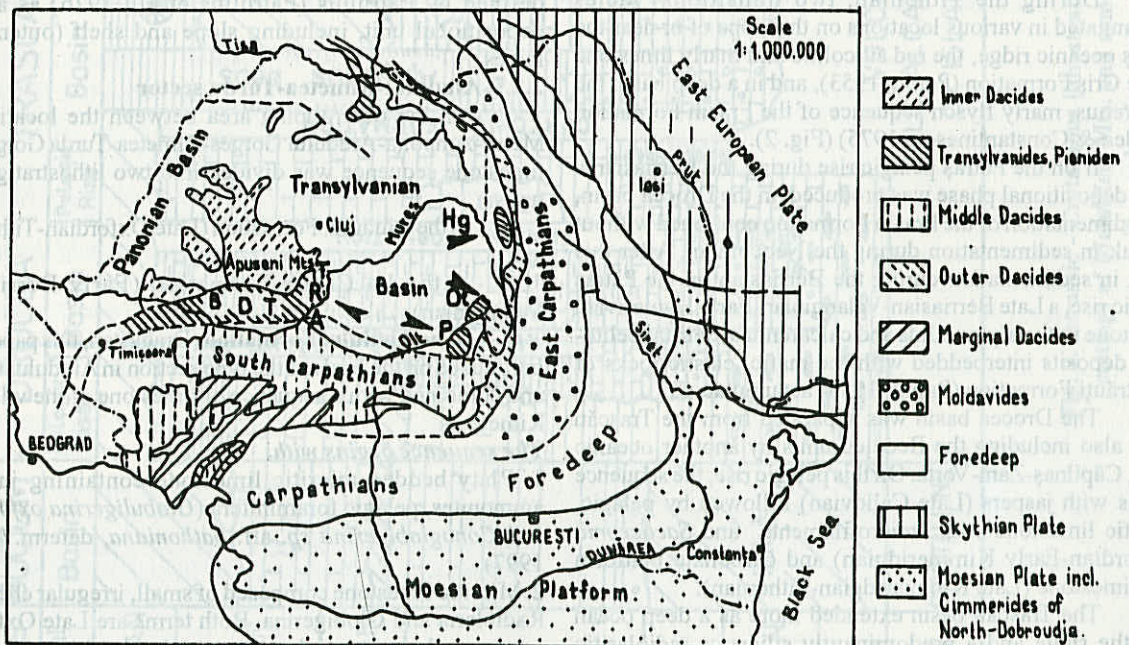


Fig. 1. Tectonic sketch - map of the Romanian Carpathians, including the Southern Apseni Mts. (= Metaliferi Mts.: B - Bucium, D - Drocea, T - Trascău) and Central Transylvanian carbonate platform (A - Aiudului Gorges, R - Rimetea, T - Turda Gorges, P - Perşani, Ot - Olt, Hg - Haghimaş.

2.1. The Metaliferi Mountains

The sedimentary cover of Crystalline basement (Bucium area) and volcanic island arc belong to the Bucium, Drocea and Trascău troughs. The troughs are separated by two pelagic rises, one named Pătraş - Şoimuş - Buceava and another Căpilnaş - Zam - Vorta.

In the Bucium trough over the metamorphic basement, the flysch, black shales and sandstone intercalations are disposed, attributed to the Tithonian-Early Berriasian (Bordea and Constantinescu, 1975). After a short hiatus in the Middle Berriasian a pelagic calcilititic sequence with scarce Calpionellids was found, Late Berriasian-Valanginian.

In the Drocea trough many transitional facies were identified. Over the volcanic calc-alkaline rocks of island arc a predominantly siliceous sedimentary phase of radiolarite and jaspers cover the volcanic rocks, being Late Callovian-Early Tithonian in age. (Dumitrică, 1981).

The Pătraş-Şoimuş-Buceava pelagic rise operated like a ridge between the Bucium and Drocea basins. On the pelagic rise the sedimentary sequence contains the radiolarite /jasper overlays by pelagic red argillaceous, shale interbedded with short phase lithons of calcilitite and sandstone during the Kimmeridgian and the Early Tithonian followed by carbonate platform, reef-massive limestone facies, in the Late Tithonian. During Jurassic-Cretaceous boundary the pelagic rise area sank and the turbiditic, submarine erosional streams generated a Berriasian non-depositional gap.

In the Drocea basin, the sedimentation started by a siliceous radiolaritic sequence followed by a pelagic, red nodular limestone (Ammonitoco Rosso) with a marly matrix and ammonites (Oxfordian-Early Tithonian).

During the Tithonian, two transitional facies accumulated in various locations on the slope of or near the Pătraş oceanic ridge, the red silicilitic and marly limestone of the Criş Formation (Papiu, 1953), and in a deep basin the calcareous, marly flysch sequence of the Frasin Formation (Bordea & Constantinescu, 1975) (Fig. 2).

If on the Pătraş pelagic rise during the Berriasian a non-depositional phase was produced, in the Drocea basin, the sedimentation of the Frasin Formation continued without a break in sedimentation during the Neocomian. After this break in sedimentation during the Berriasian on the Pătraş pelagic rise, a Late Berriasian-Valanginian-Early Hauterivian limestone with calpionellids and calcarenites, detrital pelito-siltic deposits interbedded with the mafic, clastic rocks of the Străuţi Formation (Papiu, 1953) accumulated.

The Drocea basin was separated from the Trascău basin also including the Bedeleu units by another oceanic ridge, Căpilnaş-Zam-Vorta. On this pelagic rise, the sequence begins with jaspers (Late Callovian) followed by pelagic, micritic limestone with "microfilaments" and *Sacoccoma* (Oxfordian-Early Kimmeridgian) and carbonate platform reef-limestone (Late Kimmeridgian-Tithonian).

The Trascău basin extended more as a deep ocean near the ridge and a predominantly siliceous radiolaritic sedimentation (Kimmeridgian-Early Tithonian). The sequence continued with green-gray pelagic limestone interbedded with red argillaceous shales of the Curechiu Formation (Primics, 1896).

The pelagic limestone and red argillaceous shales of the Curechiu Formation continued without any break of sedimentation during the Tithonian and Neocomian. The Neocomian age was established according the calpionellids association. The presence of Hauterivian has been until now presumed.

The Bedeleu area corresponds to the deep facies basin which included the red nodular limestone with ammonites (Late Oxfordian-Kimmeridgian-Early Tithonian) and red, green, gray micritic limestone and marls with calpionellids of *Aptychus beds* (Late Tithonian-Neocomian) without any break of sedimentation. In the same area the sequence contains cherts and bedded limestone with ammonites (Late Oxfordian-Early Kimmeridgian), pelagic micritic limestone with *Sacoccoma* and radiolaria (Late Kimmeridgian-Early Tithonian) and pelagic limestone with calpionellids (Late Tithonian-Early Berriasian) (Dragastan, 1966, 1996a).

This sequence corresponds to the Bedeleu Formation (Late Oxfordian-Early Berriasian) now introduced by Dragastan. The type section is in the Bedeleu ridge of Trascău Mountains near the village of Izvoarele.

The lithostratigraphic sequence of the Bedeleu Formation belongs to a transitional facies from the deep basin to the slope situated near the Mureş and Central Transylvanian carbonate platforms. The possibility is not excluded that the Mureş carbonate platforms belong to the large Transylvanian carbonate platform. After a Middle Berriasian-Valanginian break of sedimentation the transgressive micritic limestone with *Hedbergella* points to the Hauterivian.

2.2. The Central Transylvanian carbonate platform

The Central Transylvanian carbonate platform was defined by Patruşiu (Patruşiu et al., 1976) as a large depositional unit, including slope and shelf (outer/inner) facies.

2.2.1. Aiudului-Rimetea-Turda sector

In the outcropping area between the localities of Meleş-Ampoiţa-Aiudului Gorges-Rimetea-Turda Gorges, the limestone sequence was divided into two lithostratigraphic units:

- the Aiudului Formation (Late Oxfordian-Tithonian) and
- the La Cetate Formation (Early Berriasian-Valanginian).

The Aiudului Formation (Dragastan, this paper) was introduced on the basis of the type section in Aiudului Gorges and combined with a sequence of limestone of the village of Rimetea.

The sequence begins with:

1. Platy bedded micritic limestone containing juvenile ammonites, pelagic foraminifera (*Globuligerina oxfordiana* and *Conoglobigerina sp. aff. bathoniana*, determ. Neagu, 1997);
2. Micritic limestone composed of small, irregular chert with Radiolaria and Globigerina. Both terms are Late Oxfordian in age and correspond to the condensed bimodal facies transgressively disposed on the "ophiolite" basement (Fig. 2);
3. Red nodular limestone containing only juvenile shells of ammonites and crinoid plates of *Sacoccoma*;

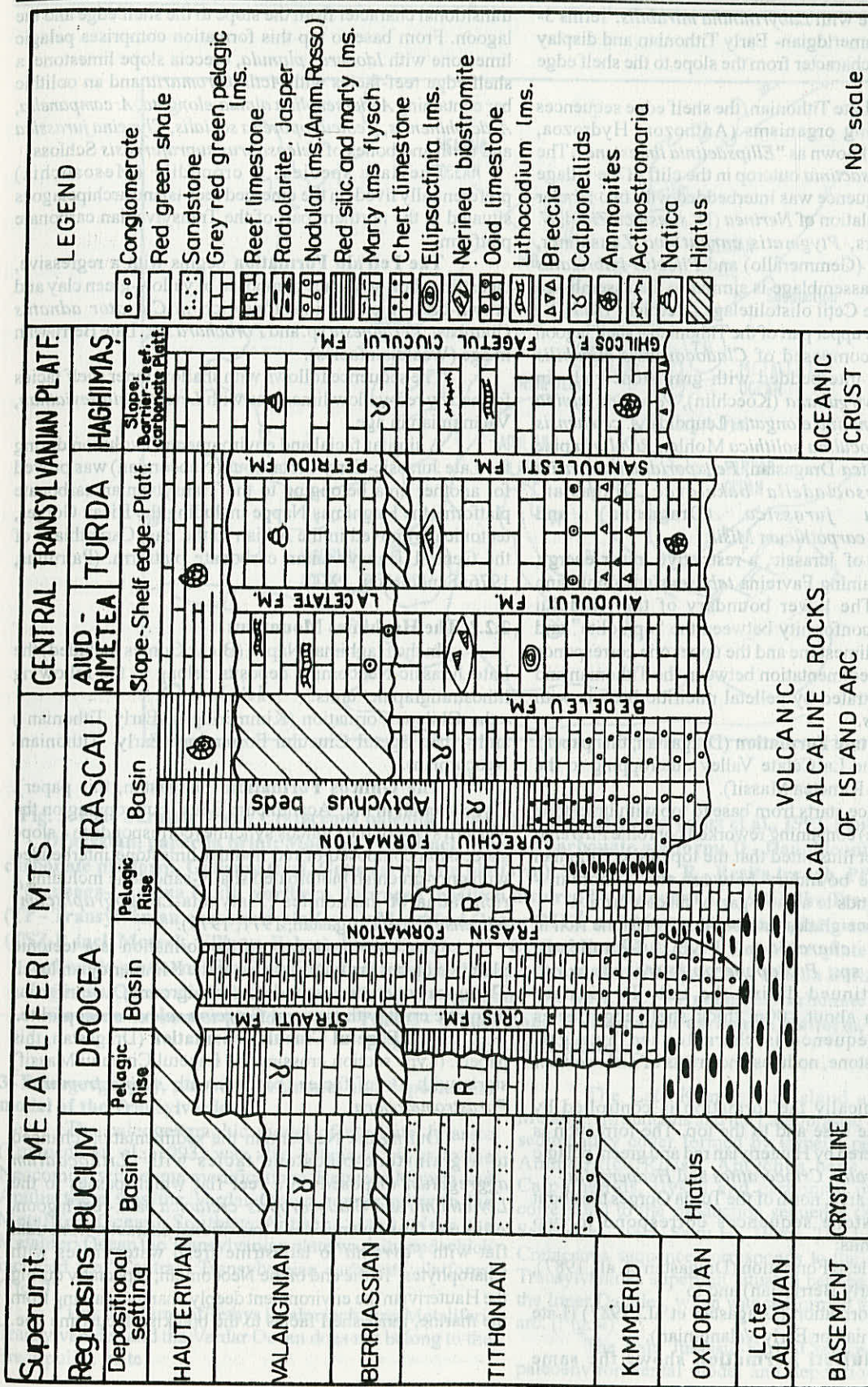


Fig. 2. Jurassic - Cretaceous lithostratigraphic units and depositional settings of Metalliferi Mts. and some "Segments" of the central Transylvanian carbonate platform.

4. Micritic limestone with *Labyrinthina mirabilis*. Terms 3-4 belong to the Kimmeridgian- Early Tithonian and display a transitional facies character from the slope to the shelf edge carbonate platform.

During the Late Tithonian, the shelf edge sequences contain reef-building organisms (Anthozoa, Hydrozoa, Sponges, Bryozoa), known as "*Ellipsactinia limestone*". The sequence with *Ellipsactinia* outcrop in the cliff of the village of Rimetea. The sequence was interbedded with two tabular biostromite accumulation of *Nerinea* (N. *silesiaca* Zittel, N. *hoheneggeri* Peters, *Ptygmatis carpathica* Zeuschner, *Diptyxis bidentatus* (Gemmerallo) and *Pileolus imbricatus* Gemmerallo). This assemblage is similar to the assemblage found at the Pietrele Ceții olistolite (Herbich, 1877).

Towards the upper part of the Tithonian a shelf lagoon sequence appears composed of *Cladocoropsis mirabilis* micritic limestone interbedded with grainstone rich in *Everticyclammina virguliana* (Koechlin), *Valvulina alpina* Dragastan, *Andersenolonia elongata* (Leupold), *A. ceteaensis* (Dragastan), *Nautiloculina oolithica* Mohler, *Rivularia piae* (Frollo), *R. carpathica* Dragastan, *Felixporidium atanasiui* (Dragastan), *Dissocladella bakalovae* Dragastan, *Pseudocymopolia jurassica* (Dragastan) and *Pseudolithocodium carpathicum* Misik.

To the end of Jurassic, a restrictive lower energy, pelletal facies containing *Favreina tabasensis* Brönnimann has been found. The lower boundary of the Aiudului Formation is a disconformity between the "ophiolite" and the Late Oxfordian limestone and the upper one corresponds to a short break in sedimentation between the Tithonian and the Berriasian illustrated by pelletal micritic breccia with *Favreina tabasensis*.

The La Cetate Formation (Dragastan, this paper). (Type section on the La Cetate Valley outcropping to the eastern slope of the Rimetea Massif).

The sequence starts from base to top with limestone breccia (intramicrite) containing reworked coprolite *Favreina tabasensis*. This fact illustrated that the top of the Tithonian is missing and the boundary between the Tithonian - Berriasian corresponds to a short gap or disconformity.

The sequence grades into oolitic limestone rich in *Andersenolonia cherchiaie* (Arnaud-Vanneau), *Pseudocymopolia* sp., *Protopeneroplis trochangulata* Septfontaine continued during the Late Berriasian-Valanginian by an about 100m thick shelf edge facies sequence. This sequence is characterised by algal-foraminiferal grainstone, nodules and crusts of *Lithocodium aggregatum*.

Stratigraphically the formation is controlled by disconformity to the base and to the top. The formation is transgressively covered by Hauterivian red and green, pelagic limestone with *Duvalia*, *Crioceratites* and *Hedbergella*.

In the same area, north of the Turda Gorges the about 600m thick limestone sequences correspond to two lithostratigraphic units:

- the Săndulești Formation (Dragastan et al., 1987), (Late Oxfordian-Early Berriasian) and to
- Petridu Formation (Dragastan et al., 1987) (Late Berriasian-Valanginian or Early Valanginian).

The Săndulești Formation shows the same

transitional character from the slope to the shelf edge and the lagoon. From base to top this formation comprises pelagic limestone with *Idoceras planula*, breccia slope limestone, a shelf edge reef-facies with *Actinostromaria* and an oolitic bar containing *Andersenolonia alpina-elongata*, *A. campanella*, *A. delphinensis*, *Neoteutoporella socialis*, *Clypeina jurassica* and teeth and bones of *Teleosaurus suprajurensis* Schloss.

The last species, a crocodile (Mesosuchia) preferentially lived on the emerged reef-island archipelagoes situated in the northern part of the Transylvanian carbonate platform.

The Petridu Formation begins with a regressive, lacustrine short sequence composed of yellow-green clay and brown-grey micritic limestone rich in *Clavator adnatus* Grambast, *Perimneste* sp. and *Porochara* sp., Late Berriasian in age (Wealdian facies).

The sequence follows with shallow inner shelf facies formed by red-yellow limestone with *Leviathania leviathan*, Valanginian in age.

A similar facial and environmental evolution during the Late Jurassic-Early Cretaceous (Neocomian) was proved for another area belonging to the Transylvanian carbonate platform, the Haghimaș Nappe including the Bicaz Gorges, tectonically moved in the Albian to the East Carpathians of the Central Transylvanian carbonate platform. (Patrulius, 1976; Săndulescu, 1984).

2.2.2. The Haghimaș Mountains

In the Haghimaș Nappe (Bicaz Gorges included) the Late Jurassic-Neocomian deposits belong to the following lithostratigraphic units:

- the Ghilcoș Formation (Kimmeridgian-Early Tithonian)
- and - the Făgetul Ciucului Formation (Early Tithonian-Neocomian).

The Ghilcoș Formation (Dragastan, this paper). (Type section in the "Acanthicum Beds" outcropping on the western slope of the Ghilcoș syncline) corresponds to a slope succession composed of red nodular limestone interbedded with grey-greenish bioturbated shaly-sandstone including a rich fauna of ammonites (Platynota-*Lithogographicum-Ulmense* Zone, Dragastan, 1971, 1975).

The lower boundary of the formation is a tectonic plain which cut the Late Jurassic at the Kimmeridgian level. The upper ones correspond to a hardground, a ferriferous limonitic crust with frequent *Favreina salevensis* coprolite.

The Făgetul Ciucului Formation (Dragastan, this paper). (Type section crossing the Făgetul Ciucului Massif) starts with a reef facies (barrier) with *Actinostromaria* - *Parastromatopora*.

During the Neocomian the sedimentation changed to a grainstone-bindstone facies with *Lithocodium aggregatum* disposed on a reef flat which passes to the *Leviathania* and *Cladocoropsis cretacea* back-reef lagoon. At its end the sequence has a transitional character from tidal flat with *Favreina* to lacustrine fresh water facies with Charophytes. To the end of the Neocomian, especially during the Hauterivian the environment deeply changed passing from the marine, inner shelf facies to the brackish-lacustrine one.

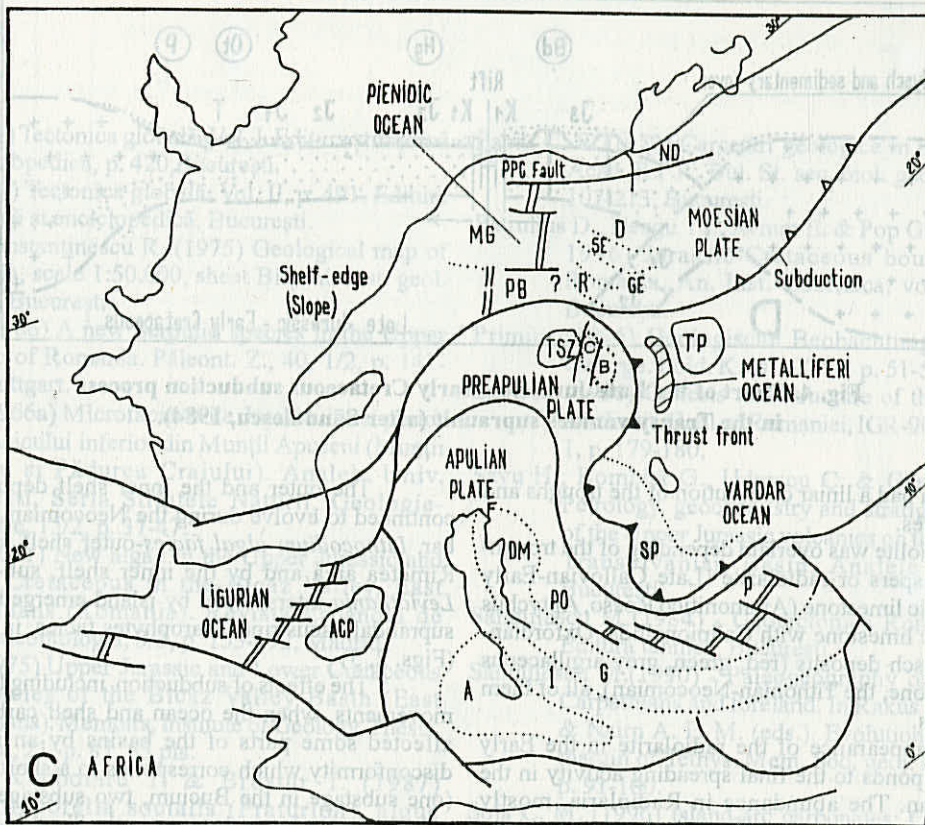


Fig. 3

Fig. 3. Late Jurassic-Early Cretaceous paleobiogeography inspired by Dercourt et al., 1993, Sengor et al., 1996, Dragastan, paper in print: Moesian Plate (incl. Moesian carbonate platform; D - Danubicum - Mehedinți carbonate platform, Geticum (incl. Getic carbonate platform), SE - Severin, R - Resița trough, PPC - Fault, Proto-Peceneaga-Camena Fault, Northern Dobrogea (position inspired by Sengor et al., 1996), the Transylvanian Plate (TP - Transylvanian carbonate platform), Metalliferi Ocean (MET and Mureș carbonate platform), the Tisza Plate (TSZ P. incl. Mecsek, Villany, Bekes), Inner Dacides (C - Crisia Microplate, B - Bihor Microplate - incl. Bihor carbonate platform, Vașcău and Codru trough), Pienidic Ocean (incl. Măgura and Poiana Botizei Plates), the Ligurian Ocean (incl. Briançonnais Plate), the Apulian Plate (incl. ACP - Apennines carbonate platform, G - Gavrovo carbonate platform, PO - Pindos - Olonos Zone, P - Parnassos carbonate platform, SP - Serbo-Pelagonian carbonate platform).

3. Paleogeography, paleoenvironments and depositional model of the Transylvanides.

The paleogeographic model of the Late Jurassic (Fourcade et al., 1993) was also extended by us to the Neocomian with some modifications. Between Moesia and Apulia there was the Vardar Ocean connected with the Metalliferi Ocean (Southern Apuseni Mts.). Near the Metalliferi Ocean the Transylvanian plate was situated which included the "Central" Transylvanian carbonate platform. (Fig. 3)

This large area of Tethys Realm including Metalliferi, Transylvanides and the Vardar Ocean does not belong to the Pre-Apulian plate.

The Late Kimmerian island arc volcanism of Metalliferi Mountains and the Late Jurassic - Early Cretaceous sedimentary cover formed by jaspers, pelagic limestone - Ammonitico Rosso, Aptychus beds, limestone with Calpionellids, flysch and carbonate platform deposits correspond to the subduction sequence (Săndulescu, 1990, Savu et al. 1995, Savu H., 1996). The Late Jurassic-Early Cretaceous sequence corresponds to the subduction of the Transylvanides superunit situated between the Median and the Inner Dacides, when was performed the volcanic island arc. (Fig. 4)

The Late Jurassic-Early Cretaceous (Neocomian) paleoenvironmental model and depositional setting of the

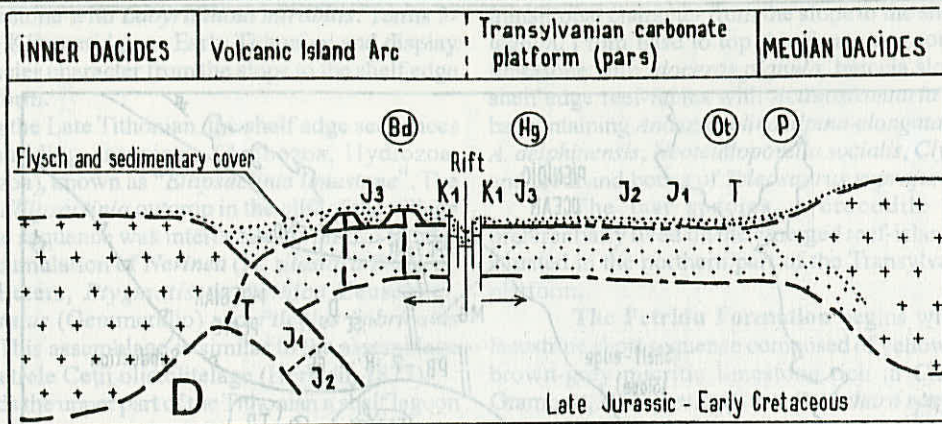


Fig. 4. Chart of the Late Jurassic - Early Cretaceous subduction process in the Transylvanides supraunit (after Săndulescu, 1984).

Metaliferi Ocean had a linear distribution of the troughs and of the pelagic rises.

The ophiolite was overlaid depending of the trough-basins by the jaspers or radiolarite (Late Callovian-Early Tithonian) pelagic limestone (Ammonitico Rosso, Aptychus beds and pelagic limestone with Calpionellids, Oxfordian-Neocomian), flysch deposits (red, green, grey argillaceous shale and sandstone, the Tithonian-Neocomian), all of them deep basin facies.

The disappearance of the radiolarite in the Early Tithonian corresponds to the final spreading activity in the Metaliferi Ocean. The abundance in Radiolaria, mostly pelagic-planktonic microfossils reflects the high productivity correlated with upwelling currents distributed in a small "ocean" like a narrow trough.

The Ammonitico Rosso, pelagic nodular carbonate (Late Oxfordian-Early Tithonian) developed on the pelagic rise and in a deep and slope basins are distributed between the pelagic rise and the deep basin and on the slope of the carbonate platform.

The flysch deposits (argillaceous shale and sandstone) appeared in the basins situated on the continental margins and of both sides of pelagic rise (for example, Bucium).

The pelagic limestone with Calpionellids, Aptychus beds, flysch deposits (Tithonian-Neocomian) accumulated on the pelagic rise, to the deep oceanic and on the slope basin.

The cherts - nodules of platy, bedded limestone with ammonites (Late Oxfordian -Kimmeridgian) indicate deep oceanic and slope to the shelf-edge basins (Trascău, Bedeleu and Rimetea Aiudului). The transition from the Metaliferi Ocean to the "Central" Transylvanian carbonate platform corresponds to a "calcareous linear ridge" disposed on the ophiolite, in the Aiudului-Rimetea-Turda area.

In the Aiudului-Rimetea area, the *Ellipsactinia* shelf-edge facies was identified, continuing to the top with *Cladocoropsis* limestone and *Nerinea* biostromite of the inner shelf (back-reef) facies. To the north, the Turda area, the *Actinostromaria* outer shelf (fore-reef) facies was found (Tithonian in age).

The outer and the inner shelf depositional setting continued to evolve during the Neocomian by the oolitic bar, *Lithocodium* algal facies-outer shelf in the Aiudului-Rimetea area and by the inner shelf, sub-intertidal with *Leviathania* interspersed by island-emerged archipelagoes, supratidal, lacustrine Charophytes facies, in the Turda area. (Figs. 2, 5)

The effects of subduction including Late Kimmerian movements, when the ocean and shelf carbonate platform affected some parts of the basins by an intra-berriasian disconformity which corresponds to a short, term gap-time (one substage in the Bucium, two substages on the Pătraș pelagic rise or two substages in the Trascău basin including the Bedeleu Formation). These movements also affected by short, term gap-time (substages) the slope and the shelf of the Transylvanian carbonate platform (Aiudului-Turda area). Some deep oceanic basin, like Drocea (the Frasin Formation) and Trascău (the Curechiu Formation and the Aptychus beds of the Bedeleu System) remain non-affected by these movements. The Jurassic-Cretaceous sedimentation continued here without any depositional break.

The other "segments" of the Transylvanian carbonate platform is the Haghimaș area. During the Late Jurassic-Early Cretaceous (the Ghilcoș Formation and the Făgetul Ciucului Formation) the paleoenvironmental facies model points out that Haghimaș evolved in a seamount depositional system (Fig. 5)

The Haghimaș seamount carbonate platform had a bilaterally west-east slope sedimentation. On the "west" slope, the Ammonitico Rosso of the Ghilcoș Formation was accumulated and on the "east" slope the pelagic Calpionellids limestone included in the Făgetul Ciucului Formation. The shelf carbonate sedimentation was developed between the slopes of the Haghimaș Seamount. The outer shelf facies with *Actinostromaria*, *Lithocodium* barrier-reefs was separated by large lagoon-facies with *Parastromatopora* and *Cladocoropsis*.

On the west slope, in the Ghilcoș Formation an Intratithonian hardground was identified reflecting a short non-depositional phase in a "ridge" area of the slope and

continues the depositional sequence uninterrupted during the Tithonian-Neocomian.

As Recent, the Haghimaş Seamount corresponds to

a discrete, linear disposition, perhaps aligned along a ridge or rise of the Tethyan Realm.

References:

- Bleahu M. (1981) *Tectonica globală*. Vol. I. Editura științifică și enciclopedică, p. 420, București.
- Bleahu M. (1989) *Tectonica globală*. Vol. II, p. 491. Editura științifică și enciclopedică, București.
- Bordea S. & Constantinescu R. (1975) Geological map of Romania, scale 1:50.000, sheet Blajeni. *Inst. geol. geofiz.*, București.
- Dragastan O. (1966) A new Serpulid species in the Upper Jurassic of Romania. *Paleont. Z.*, 40, 1/2, p. 147-150. Stuttgart.
- Dragastan O. (1966a) Microfaciesurile Jurasicului superior și Cretacicului inferior din Munții Apuseni (Munții Trascău și Pădurea Craiului). *Analele Univ. București, Seria Științele Naturii, Geologie-Geografie*, 15/2, p. 37-47.
- Dragastan O. (1971) New algae in the Upper Jurassic and Lower Cretaceous in the Bicaz Valley, East Carpathians (Romania). *Revista Espanola de Micropaleontologia*, 3/3, p. 155-192, Madrid.
- Dragastan O. (1975) Upper Jurassic and Lower Cretaceous Microfacies of the Bicaz Valley Basin (East Carpathians). *Memoirs, Institute of Geology, Thesis, Romania*, 21, p. 87, 65 pls.
- Dragastan O., Ciubotaru T. & Brustur T. (1987) *Néoteutlopoporella socialis* (Praturlon), algue "recifale" du domain Tethysien. *Revue de Paléobiologie* 6/1, p. 143-149, Genève.
- Dumitrică P. (1981) The structure of the West Carpathians Mountains, In: M. Bleahu et al. *Carpatho-Balkan Geol. Assoc. XII Congress, Guidebook, Excur. B3*, p. 107, Bucharest.
- Fourcade E. et al. (1993) Late Tithonian (138 to 135 Ma.), p. 113-152, Text & Maps, in: Dercourt J., Ricou L. E. & Urielyncck B. eds. *Atlas Tethys - Palaeoenvironmental Maps*, E.A.P.G., Paris.
- Papiu C. V. (1953) Cercetări geologice in masivul Drocea. *Acad. R.P.R. Bul. St. sec. biol. geol. geogr.*, V/1, p. 107-213, București.
- Patruluius D., Neagu Th., Avram E. & Pop Gr. (1976) (Sofia, 1996) Jurassic-Cretaceous boundary beds in Romania. *An. Inst. Geofizica*, vol.L, p. 71-125. București.
- Primics (1896) *Geologische Beobachtungen im Csetras Gebirge*. *Föld. K.* (sl., Xviii, p. 51-58, Budapest.
- Savu H. (1996) Genesis and structure of the Mureş Zone. *An. Institut. Geol al Romaniei, IGR-90*, vol. 69, suppl. 1, p. 179-180.
- Savu H., Bombiță G., Udrescu C. & Garbari G. (1995) Petrology, geochemistry and stratigraphic position of the Upper Jurassic volcanics on the bottom of the Transylvanian Basin. *Analele Universității București*.
- Săndulescu M. (1984) - *Geotectonica României*, p. 334, Editura tehnică, București.
- Săndulescu M. (1990) - *Paleogeography of the romanian Carpathians and foreland*. In Rakus M., Dercourt J. & Nairn A. E. M. (eds.). *Evolution of the northern margin of Tethys*. *Mem. Soc. geol. France*, 154, II, p. 91-100.
- Soja C. M. (1996) Island-arc carbonates: Characterization and recognition in the ancient geologic record. *Earth-Science Reviews* 41, p. 31-65.
- Sengor A. M. C. (1996) Tectonics of the Mediterranean Cimmerides: nature and evolution of the western termination of Palaeo-Tethys, in: *The Geological Evolution of the Eastern Mediterranean*. (Robertson A. H. F. & Dixon J. E. editors), p. 77-112, Geological Society, Special Publication No. 17, London.

TRANSILVANIIDES

SOUTHERN APUSENI

HAGHIMAS SEAMOUNT

ISLAND ARC

OPEN SEA

REEF FLAT PLATFORM

OPEN SEA

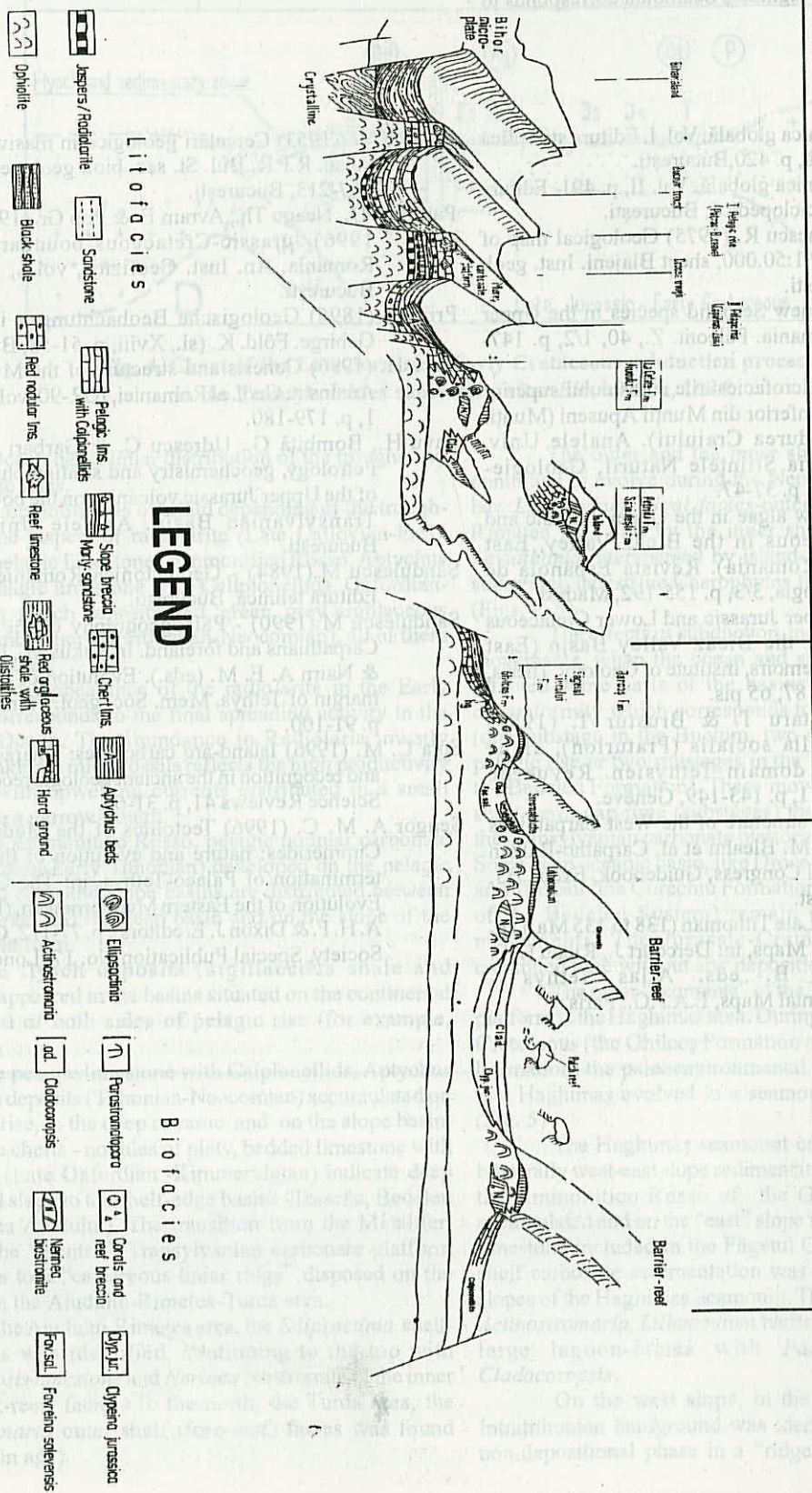


Fig. 5. The Late Jurassic - Early Cretaceous depositional and paleoenvironmental reconstruction model of the Transylvanides supranit.