MICROFACIES ANALYSIS OF CHERTS IN UPPER PALAEOLITHIC SITES ALONG THE LOWER DANUBE VALLEY (ROMANIA)

Alexandru CIORNEI[(1)], **Izabela MARIŞ**[(2)], **Barbara SOARE**[(2)]

[(1)] *e-mail: hammerfall1996@yahoo.com*
[(2)] *Faculty of Geology and Geophysics, University of Bucharest, 36-46 Mihail Kogalniceanu Blvd., 050107 Bucharest, Romania*
e-mail: izabela@contentlogic.ro; baby.soare@gmail.com

Abstract. This article focuses on the petrographic analysis of chert samples from the Lower Danube Valley, Romania, between West of Olt Valley and East of Mostiştea Valley (Upper Palaeolithic sites and modern quarries in gravels of Frăteşti Formation and Danube terrace deposits). Macroscopic examination of hand specimens established visual characteristics of cherts and allowed the primary separation of samples. Microfacies analysis was carried on 116 thin sections, with special attention to grain categories, recognition of systematic fossil groups, matrix, and cement types, estimated by use of visual comparison charts for each thin section. Bulk dominant mineralogical phases were determined through X-ray diffraction on 82 samples. Microfacies analysis provided the means to characterize and classify cherts from the Lower Danube Valley (22 chert microfacies), demonstrating that raw-materials were previously inadequately characterized and defined too generally. Also, this study confirmed older hypotheses about local alluvial deposits as supply sources for some of the Upper Palaeolithic sites.

Key words: chert, microfacies analysis, chert microfacies, chert provenance, chert sources, Lower Danube Valley, Upper Palaeolithic.

1. INTRODUCTION

Throughout its history, Romanian Palaeolithic research counts a handful of disparate and isolated studies regarding characterization and provenance of *lithic raw-materials** used for tools production in sites relating to this period. The majority of Palaeolithic researchers contented themselves with recognizing broad categories of raw-materials (such as silex/flint, siliceous sandstone, quartzite, obsidian, and so on) encountered in the excavated lithic assemblages.

Awareness regarding raw-materials and supply sources has developed in two intertwining research directions. The first is represented by the use of standard petrographic textbooks to describe rock types found in Palaeolithic sites, trying at the same time to prove provenance of those raw-materials through geological information about physiographic distribution of such rocks (Păunescu, 1970; Mogoşanu, 1978; Păunescu, 1996-1998; Cârciumaru *et al*., 2000). The second direction took the form of collaboration between archaeologists and geologists that resulted in a few raw-material characterization studies: petrographic bulletins for 36 samples prepared by Clarissa Papacostea, one of them from Giurgiu-Malu Roşu (Păunescu, 1970: 83-89); identification of raw-materials from Vădastra-Măgura Fetelor (Protopopescu-Pache and Mateescu, 1959); petrographic analysis of raw-materials in Middle Palaeolithic levels at Boroşteni-Peştera Cioarei (Muraru, 1987; Cârciumaru *et al*., 2000); petrographic analysis of raw-materials from Giurgiu-Malu Roşu (Alexandrescu and Soare, 2009).

Previous archaeological research in Upper Palaeolithic sites from Lower Danube Valley identified Upper Cretaceous flint/silex as the main raw-material used by Palaeolithic people for tools (Nicolăescu-Plopşor *et al*., 1956: 225-226; Protopopescu-Pache and Mateescu, 1959: 13; Păunescu *et al*., 1962: 130; Păunescu, 1966: 331; Boroneanţ *et al*., 1983: 14-15). Sources of flint were considered to be either nearby alluvial deposits found on the left side of Danube, either host-rock deposits found in Bulgaria (Upper Cretaceous chalk deposits).

* *Lithic raw-materials* is used here as a term encompassing different types of stones, from coarse-grained and fine-grained volcanic, metamorphic to sedimentary rocks that have been used in prehistoric artifacts production.

In the area between Southern Carpathians and Lower Danube Valley, Păunescu (2000) has systemized geological information about "natural deposits of raw-materials" and outlined "micro-zones" with possible supply sources. Along Danube's Valley, raw-materials (flint) suited for knapping are found in "Frăteşti Gravels" (around Giurgiu, at Ghizdaru-Haltă Quarry and Cetatea-Bălănoaia Quarry), while "natural deposits with flint" are buried under Danube's lower terrace at Ciuperceni-Quarry (Păunescu, 2000: 56-57).

South of this area, in Northern Bulgaria, Gurova and Nachev (2008: 33-34, and Fig. 5) have round-up the main flint types archaeologically relevant: pale gray and reddish-brown Haemus flint found as silica concretions in micrite limestones (Oxfordian, Upper Jurassic), cropping out in North-West Bulgaria; Moesian flint (brown, pale brown and gray, spotted structure) from Campinian chalks and chalk-like limestones and in Maastrichtian fine-grained biomorphic limestones (Upper Cretaceous), cropping out in 3 areas (Montana-Lovech, Pleven-Nikopol, Shumen-Devnya), and considered to be the famous "Balkan flint"; two types of Ludogorie/Luda Gora/ Dobrogea flint (pale brown and beige, rarely gray) found in Aptian (Lower Cretaceous) micrite limestones, cropping out in North-East Bulgaria between Novi Pazar, Ruse and Dobrich.

Crandell's (2013: 126-129) recent study regarding raw-materials from Neolithic sites in Southern Romania (Teleorman County) overviews geological siliceous lithic materials and groups them as source areas based on macroscopic and microscopic characteristics: Balkan flint (Murfatlar type flint/Dobrogea flint/Moesian flint), gray to yellow color with whitish spots, from Late Cretaceous chalk deposits found in Bulgaria (along the Danube) and Dobrogea (in South-Eastern Romania); Oltenian flint (brown or dark brown-gray to black variety of Balkan flint) found in alluvial deposits along the Danube in Oltenia and Muntenia areas (Southern Romania); Dobrogea chert (color ranging from yellowish-beige to medium-dark browns and light to dark gray) represents two siliceous materials, one from Oxfordian-Kimmeridgian limestone deposits (Upper Jurassic), and one from Aptian-Turonian limestones (Lower to Upper Cretaceous), found in areas around Tulcea, Constanța, and Mangalia (South-East Romania), South of the Romanian-Bulgarian border and along the Danube as far as Nikopol, but also in alluvial deposits along Danube (associated with "Balkan flint").

Regionally flint/chert types defined in Gurova and Nachev (2008) and Crandell (2013) enclose materials from the same geological period or age (in some cases from different periods) with similar or variable macroscopic aspects (colors, shades and play of colors, structure and texture) and mineralogically-oriented and insufficiently understood microscopic characteristics (observations under microscope are limited to recognition of authigenic silica mineral phases and their texture, and some information about biodetritus and content of other mineral phases). The probability that regionally defined flint/chert types might include different varieties, that should be acknowledged as such, is supported by conflicting results of comparative thin sections and geochemical analysis between archaeological and geological samples from Bulgaria (Bonsall *et al.*, 2010).

Faced with this general picture of flint types and the scarcity of petrographic analysis of raw-materials in Palaeolithic sites (and later periods) in Southern Romania, a detailed inquiry regarding cherts becomes a real necessity. This article presents the results of a small-scale study of cherts used as raw-materials in Upper Palaeolithic sites along Lower Danube Valley (Ciornei, 2013), centered on microfacies analysis as a basic investigation tool.

2. GEOLOGICAL CONTEXT

The Upper Palaeolithic open-air sites included in this study are located in loess and loess like deposits (15/20 m to 30-40 m thick) covering Danube's terraces and older alluvial sediments (Table 1). The study area is represented by a West-East portion of the Lower Danube Valley (covering parts of Oltenia and Muntenia regions in Southern Romania) between West of Olt Valley and East of Mostiştea Valley, not extending beyond the northern limit of Danube Valley and the river's water line (Pl. 1).

The investigated area overlays a restricted part of the structural-tectonic unit called Moesian Platform (Valahian Sector). Valahian Sector extends between Subcarpathian Nappe (Pericarpathian Fault) to North, Southern Carpathians to West, Danube to South and South-Dobrogean Platform to East (Fierbinți Fault) (Enciu, 2007: 29; Mutihac *et al.*, 2007: 41, 45). The crystalline basement of Valahian Sector sustains a sedimentary cover accumulated during 4 sedimentary cycles (Paraschiv, 1983: 177; Mutihac *et al.*, 2007: 42): Middle Cambrian-Carboniferous, Permian-Triassic, Jurassic-Cretaceous and Neogene-Quaternary.

From Cetate to East of Mostiştea, Danube flows through a contact valley between Romanian Plain and the Prebalkanic Plateau, wide from 22 to 17-18 km (Coteț, 1969: 25-26; Mateescu *et al.,* 1969: 532; Niculescu and Senecu, 1969: 40). The Bulgarian side of the Lower Danube Valley is tilted, forming cliffs of 50-200 m above the Romanian side, which gently descends towards the water line (Oncescu, 1965: 126, 136). On the right side (in Bulgaria), crop out Upper and Lower Cretaceous chalk and limestone deposits, host-rocks for cherts in primary position, while on the left side (in Romania) crop out alluvial Pleistocene deposits with cherts in secondary position (the geology of these deposits is briefly detailed in Table 2). In the study area, cherts are found only in secondary position in Frăteşti Formation, cropping out on the right and left sides of Olt Valley, right side of Vedea Valley, Danube and Argeş valleys, and Danube's terrace deposits (Bandrabur, 1966: 17-18, 20-21; Bandrabur *et al.*, 1966: 15-16; Bandrabur *et al.*, 1967: 19; Bandrabur and Patrulius, 1967: 17; Coteț, 1976: 33).

3. MATERIALS AND METHODS

This petrographic analysis was conducted on two series of chert samples: the first series came from the Upper Paleolithic sites; the second series came from Pleistocene alluvial sediments (Frăteşti Formation and Danube's terrace deposits) opened by contemporaneous quarries (the sampling locations, see Pl. 1, Table 1). This study is based on macroscopic examination of 311 hand samples, microscopic investigation of 116 uncovered thin sections, and X-ray diffraction of 82 samples for mineralogical composition.

Macroscopic examination of hand specimens collected in the field surveys and from archaeological sites had a two-folded aim: external appearance (size, weight, morphology, color and consistency of cortex, naked eye visible fossils) and internal look (fracture, light transmittance in thin flakes, luster in fresh breaks, color and play of colors, absence/presence and distribution of carbonate relics, naked eye visible fossils).

Microscopic analysis was conducted with an Olympus BH-2 petrographic microscope, using only 4× (A4 PO, 0.10, 160/-) and 10× (A10 PO, 0.25, 160/0.17) magnifications. Microscope photographs were taken with a Nikon COOLPIX 995 (Wide Field 10× and digital zoom of 3×) photomicrograph camera using mostly the 4× magnification (for general views of thin sections), and the 10× magnification for details (such as microfauna). X-ray diffraction was conducted on a PANanalytical X'Pert θ/θ difractometer, CuK$_{\alpha}$ radiation, scan interval 2-55° 2θ, 10-56° 2θ, 15-70° 2θ, step size 0,0170°, scan step time 10 s. The X-ray diffraction in this study was conducted on uncovered thin sections. Comparison to powder X-ray diffraction patterns from Giurgiu-Malu Roşu cherts (Alexandrescu and Soare, 2009) revealed a very close resemblance to results in this study. After Folk and Weaver (1952: 500-note 1), peaks in X-ray diffraction patterns of cherts uncovered thin sections have the same intensity with peaks in chert powder X-ray diffraction patterns.

In this characterization of Lower Danube Valley cherts were applied the microfacies concepts of carbonate rocks (Flügel, 2010), with special attention given to: grain categories, amount, size, sorting, roundness, and mineralogy of grains; recognition of systematic fossil groups and petrographic fossil distribution (types, size, amount, and mineralogy of fossils); amount, texture, and mineralogy of matrix; type, amount, texture and mineralogy of cements.

Amount of grains, matrix and cement for each thin section were estimated by use of visual comparison charts. The recorded mineralogy of each grain type, cement and matrix represents the basis for estimated mineralogical composition in individual thin sections. Cumulative observations regarding dissolution, compaction (grain contacts), cementation (type and mineralogy of cements), and neomorphism (silicifcation) indicate a predominant diagenetic fabric for all samples analyzed. Depositional fabric for each thin section was inferred from the estimated amount of particles, matrix, cement, and also grain-support type and packing.

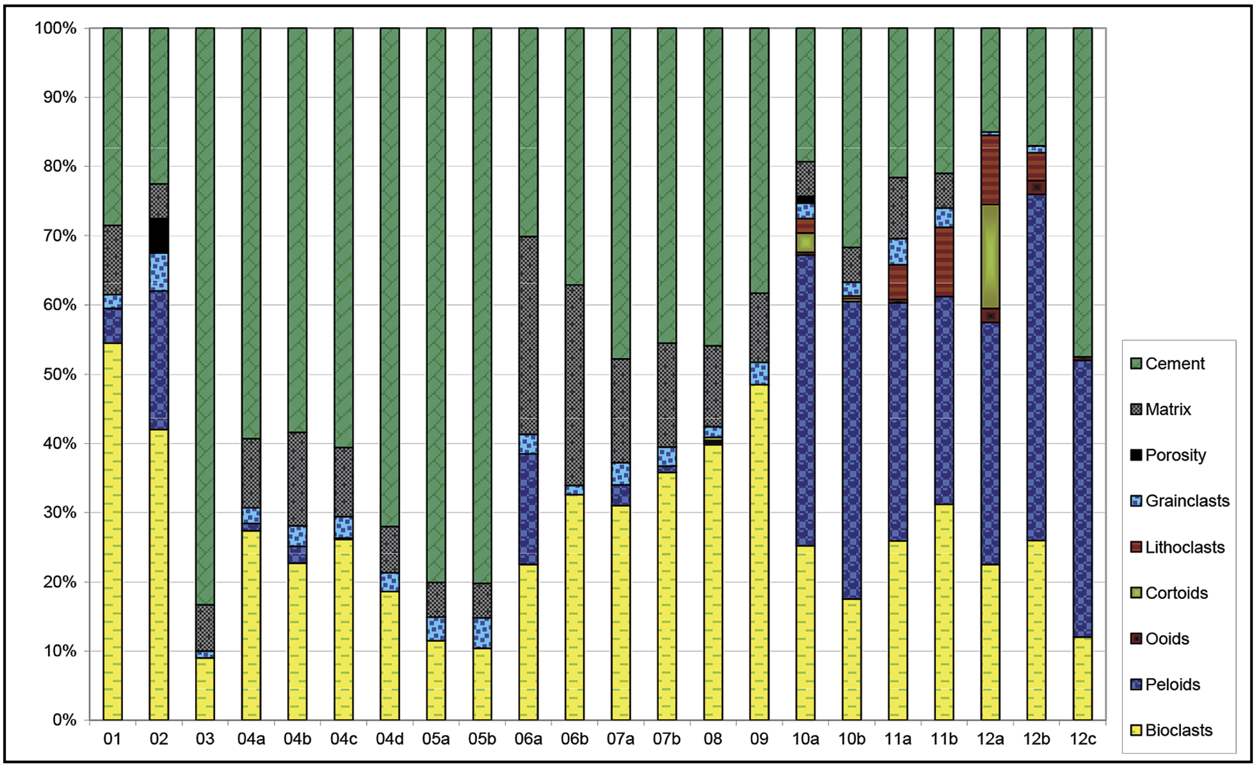

Chart 1. Chert microfacies constituents: average values were obtained from estimated primary constituents of thin sections assigned to each microfacies.

Table 1. Landmarks and geological context of chert samples from Lower Danube Valley

No.	Location	Landmarks	Geological context	Number of	
				Hand specimens	Thin sections
1	Vădastra-Măgura Fetelor (Văd-MF)	0.9 km SW form Vădastra village church; 14 km N-NW from Corabia (Olt county); 48 km W-NW from Ciuperceni-La Tir	Very sandy loess (4-6 m thick), above alluvial deposits of Danube's middle terrace (t_3)	71	7
2	Ciuperceni-La Tir (Ciup-Tir)	0.5 km N-NE from the forward movement water pipes; 2.5 km N-NE from Ciuperceni village (Teleorman county); 2 km N from *La Vii 1* site; 48 km E-SE from Vădastra	Sandy loessoid deposit (West Burnas Plain)	16	5
3	Ciuperceni-La Vii 1 (Ciup-Vii)	1.5 km E from Ciuperceni village and 7 km E from Turnu-Măgurele city (Teleorman county); 2 km SE from *La Tir* site and 49 km W-SW from *Măgura Fetelor* site	Sandy-silty loessoid deposit (4-6 m thick) from West Burnas Plain	21	8
4	Giurgiu-Malu Roşu (GMR)	0.5 km E-NE from Oinacu neighborhood (Giurgiu city, Giurgiu county); 85 km E from Ciuperceni-La Vii and 131 km E from Vădastra-Măgura Fetelor	Very fine sandy-clayey loessoid deposit (6-7 m thick), above alluvial deposits of Danube's lower terrace (t_1)	102	26
5	Nicolae Bălcescu-La Vii (NB-Vii)	0.9 km S-SW from Nicolae Bălcescu village school and church; 23 km W-NW from Călăraşi (Călăraşi county); 95 km E from Giurgiu-Malu Roşu	Silty loessoid deposit, above alluvial deposits of Danube's lower terrace (t_2)	28	6
6	Ciuperceni-Quarry (Ciup-Ca)	1.4 km from eastern limit of Ciuperceni village and 7 km E from Turnu-Măgurele city (Teleorman county); 0.2 km E from *La Vii 1* site	Frăteşti Formation (0.90 m thick massive polymictic conglomerate with chert pebbles and cobbles; laminated pinkish sand horizon with rusty-brown chert pebbles and cobbles)	24	24
7	Ghizdaru-Haltă Quarry (Gh-CH)	0.2 km E from Onceşti train station; 1.5 km NE from Ghizdaru village; 7.6 km NW of Giurgiu city (Giurgiu county); 8.9 km NW form Malu Roşu site	Frăteşti Formation (5-6 m thick laminated and cross-stratified sand deposits and cross stratified gravels)	18	18
8	Cetatea-Bălănoia Quarry (Ct-CaBl)	0.8 km from Bălănoaia village, 2 km N from Cetatea village (Giurgiu county); 7.2 km NW from Malu Roşu site	Frăteşti Formation (?)*	9	9
9	Giurgiu-South-West Quarry (Giur-Ca)	4 km SW from Giurgiu city (Giurgiu county); 7.1 km from Malu Roşu site	alluvial deposits of Danube's lower terrace (t_1) (laminated and cross-stratified sands, 5-7 m thick, laminated gravels, 0.5 m thick)	3	3
10	Giurgiu-Malu Roşu Quarry (GMR-Ca)	3.6 km E from Giurgiu city and 4 km S from Oinacu village (Giurgiu county); 3.1 km E from Malu Roşu site	alluvial deposits of Danube's lower terrace (t_1) (laminated sandy clay and sands, with thin interbeds of gravels)	3	3
11	Căscioarele-East side of the Lake (Căs-Lac)	0.2 km E from Căscioarele village and 7 km W from Chirnogi village (Călăraşi county); 51 km W-SW from Nicolae Bălcescu-La Vii site	Frăteşti Formation or alluvial deposits of Danube's middle terrace (t_3)** (laminated sands and gravels)	7	7

* Samples were collected from the surface of Cetatea-Bălănoia Quarry.
** There is still a debate about to what formation this deposits relate to.

Table 2. Neogene and Quaternary lithostratigraphic units in Southern Romania

Ma	System Period	Series Epoch	Stage Age	Lithostratigraphic units	Lithology
0.01	Quaternary	Pleistocene	Upper	Loess and loessoid deposits	clayey/sandy/silty
0.13				Terrace deposits	sands, gravels and boulders
			Middle	Barboşi-Babele Formation*	clays
				Mostiştea Formation	sands
				Călmăţui Formation	sands, gravels and boulders
0.9				Coconi Formation	marls, clays and sands
			Lower	Copăceni Beds	silt and clayey silt
				Vlădeni Formation	gravels, sands, sandy silt
				Tetoiu Formation	sands and gravels
2.6				Frăteşti Formation	sands, gravels and fine gravels, gravels and boulders
	Neogene	Pliocene	Romanian	Cândeşti Formation	sands with gravels
				Izvoarele Formation	clays, sands with coal interbeddings, gravels and sands
				Trajkovo Formation	sands, sands with gravels and gravels
3.7				Tuluceşti Formation	gravels, sands, sandy clays
			Dacian	Călineşti Formation**	sands with coaly clay and coal interbeddings
				Merişani Formation	sandy clays
				Jiu-Motru Formation	clays, sands and lignite beds
5.25				Berbeşti Formation	sands with clayey interbeddings and lignite beds, gravels with sands

* Romanian-Upper Pleistocene formation names and lithology after Andreescu *et al.* (2011).
** Dacian formation names and lithology after Enciu (2007).

Table 3. Cement types of Lower Danube Valley chert microfacies*

No.	Chert microfacies	InterPartCem	%	InterPartCem	%	CavCem	%	FracCem	%	SyntCem	%	Total %
01	spiculite wackestone chert	-	0.0	Qcc-Gr	28.5	-	0.0	-	0.0	-	0.0	28.5
02	radiolarian chert	Qm-Ineq-Xeno	25.0	Qcc-Gr	11.0	-	0.0	-	0.0	-	0.0	36.0
		Qm-Ineq-Xeno	22.5	-	0.0	-	0.0	-	0.0	-	0.0	22.5
03	planktonic foraminifera cementstone chert	-	0.0	Qcc-Gr	83.3	-	0.0	-	0.0	-	0.0	83.3
04a	phosphatized bioclastic cementstone chert	-	0.0	Qcc-Gr	58.4	Qf-By/+MQ-Dru	0.5	Qf-By	0.4	-	0.0	59.3
04b	bioclastic cementstone chert	-	0.0	Qcc-Gr	57.8	Qf-By	0.5	Qf-Fb	0.1	-	0.0	58.4
04c	sporadic hole algae-bioclastic cementstone chert	-	0.0	Qcc-Gr	59.5	Qf-By	0.8	-	0.3	-	0.0	60.6
04d	sporadic hole algae-bioclastic cementstone chert	-	0.0	Qcc-Gr	70.9	Qf-By	0.3	Qf-Fb	0.8	-	0.0	72.0
05a	cementstone chert	-	0.0	Qcc-Gr	79.1	-	0.0	Qf-By/Qm/Qf-Fb	1.0	-	0.0	80.1
05b	cementstone chert	-	0.0	Qcc-Gr	78.2	-	0.0	Qf-By+Qf-Fb	2.0	-	0.0	80.2
06a	partially silicified spiculite-peloid wackestone	-	0.0	Qcc-Gr	29.3	Qf-By	0.6	Qf-Fb	0.2	-	0.0	30.1
		-	0.0	Qcc-Gr	76.2	Qf-By	0.7	Qf-Fb	1.7	-	0.0	78.6
06b	partially silicified bioclastic wackestone	-	0.0	Qcc-Gr	35.5	Qf-By/+MQ-Dru	0.1	Qf-By	1.5	-	0.0	37.1
07a	sporadic hole algae-bioclastic wackestone chert	-	0.0	Qcc-Gr	46.8	Qf-By	1.0	-	0.0	-	0.0	47.8
07b	phosphatized bioclastic wackestone chert	-	0.0	Qcc-Gr	43.8	Qf-By/+MQ-Dru	0.2	Qf-By/Qm-Gr	1.5	-	0.0	45.5
08	hole algae wackestone chert	Qf-By/+MQ-Dru	0.8	Qcc-Gr	43.8	Qf-By+MQ-Dru	0.7	Qf-By	0.6	-	0.0	45.9
09	sponge reef chert		0.0	Qcc-Gr	38.3	-	0.0	-	0.0	-	0.0	38.3
10a	peloid-algae packstone chert	Qf-By	19.3	-	0.0	-	0.0	-	0.0	-	0.0	19.3
10b	peloid-echinoderm packstone chert	Qf-By	31.4	-	0.0	-	0.0	-	0.0	Spar	0.3	31.7
11a	peloid-echinoderm-algae packstone chert	Qf-By	6.7	Qcc-Gr	15.1	-	0.0	-	0.0	Spar	0.1	21.9
11b	bioclastic-peloidal packstone chert	Qf-By	5.0	Qcc-Gr	16.0	-	0.0	-	0.0	-	0.0	21.0
12a	peloid-cortoid grainstone chert	Qf-By/+MQ-Dru	14.0	-	0.0	-	0.0	-	0.0	Spar	1.0	15.0
12b	peloidal-bioclastic grainstone chert	Qf-By/+MQ-Dru	17.0	-	0.0	-	0.0	-	0.0	-	0.0	17.0
12c	peloidal-algal grainstone chert	Qf-By/+MQ-Dru	47.5	-	0.0	-	0.0	-	0.0	-	0.0	47.5

* InterPartCem – interparticle cement; CavCem – cavity cement; FracCem – fracture cement; SyntCem – syntaxial overgrowth cement; Qcc-Gr – granular cryptocrystalline quartz cement; Qm-Ineq-Xeno – inequigranular xenotopic recrystallized microcrystalline quartz cement; Qf-By – botryoidal chalcedony cement; Qf-Fb – fibrous chalcedony cement; MQ-Dru – drusy megaquartz cement.

4. CHARACTERIZATION AND CLASSIFICATION OF CHERTS

4.1. Chert Microfacies and Categories

From this analysis the following two characterizing and classificatory instruments for Lower Danube Valley cherts have resulted: *chert microfacies* that mirror the petrographic characteristics determined in thin section analysis, and *chert categories* regarded as tools for grouping chert microfacies with closely resembling sedimentary and diagenetic features. Using criteria mentioned in the previous section, 22 chert microfacies were differentiated, which are discussed in the following lines and text of plates 2-13.

These microfacies are grouped into 12 categories, separated by type of grain-support and predominant grain types: categories 1 to 8 include mud-supported depositional fabrics (mudstones, wackestones – composed of variable quantities of grains supported by an inferred carbonate matrix, silicified during diagenesis); categories 10 to 12 include grain-supported depositional fabrics (packstones – predominantly composed of grains supporting each other and a low matrix percentage, and grainstones – no matrix, just grains). This separation is doubled by predominant grains type (Chart 1): categories 1 to 8 are *bioclastic cherts* in which dominate skeletal grains (bioclasts); categories 10 to 12 are *peloidal cherts* in which non-skeletal grains (peloids) are prevailing.

Threshold highlighted above is strengthen by cements types (Table 3): matrix-supported fabrics contain a granular cryptocrystalline quartz cement produced through silicification of matrix; grain-supported fabrics have a botryoidal chalcedony cement and/or drusy megaquartz cement formed before silicification of peloids and remnant matrix. From this point of view, microfacies [02] stands apart through his inequigranular xenotopic microcrystalline quartz cement enclosing recrystallized radiolarians (Pl. 2). This is a bedded chert representing recrystallization of radiolarian siliceous ooze.

All samples analyzed have a diagenetic fabric overlaying the sedimentary arrangement, with silicification as the main process. Silicification intensity reflects differences in diagenetic processes, diagenetic environments and settings, and is correlated with the mineralogy of primary constituents (Table 4): very strong and strong silicification associated both with mud-/ wackestones and pack-/ grainstones is explained as silica replacing the micrite matrix and the micrite peloids; moderate and poor silicification recorded both in wackestones and grainstones is explained through mineralogical content (phosphate and organic rich micrite).

In matrix-supported fabrics (categories 1-8), silicification pattern is revealed as change in relative proportions of primary constituents: pervasive silicification of matrix resulted in cementstone cherts (categories 3, 4 and 5); moderate silicification of matrix lead to partially silicified wackestones (category 6) and wackestone cherts (categories 1, 7 and 8). In grain-supported fabrics, silicification pattern is reflected as change in mineralogical composition of primary constituents: pervasive silicification of grains and cement gave rise to peloidal-bioclastic packstone cherts (category 10) and peloidal-bioclastic grainstone cherts (microfacies [12b] and [12c]); moderate silicification of grains and cement resulted in a poorly silicified peloidal grainstone (microfacies [12a]); pervasive silicification of grains, cement and matrix resulted in peloidal packstone cherts (category 11).

Distinctions between categories and inside them were operated through bioclast content (Chart 2) versus cement (Table 3), characteristic fossil association and grain mineralogy. Cementstone cherts represented in categories 3 and 5 have as main constituent the siliceous cement enclosing a very low quantity of bioclasts. Characteristic fossil types (planktonic foraminifera) of microfacies [03] (Pl. 3) separate this chert from the other two cementstones. Both cementstones in category 5 have almost the same percentage of bioclasts, but their mineralogy differs: microfacies [05a] contains phosphatic bioclasts, while [05b] has none (Pl. 6). Cementstones in category 4 are differentiated through percentage and mineralogy of bioclasts (separating [04a] from [04b], Pl. 4), but also on the basis of characteristic fossils and their predominant mineralogy (sporadic phosphatized whole algae [04c] and sporadic carbonate whole algae [04d], Pl. 5).

Microfacies in category 6 are partially silicified bioclastic wackestones (Pl. 7 and 8), separated both at the fossil type association level and the mineralogical one: microfacies [06a] is a partially silicified organic rich carbonate predominantly composed of sponge spicules, while microfacies [06b] is a partially silicified phosphatic chalk mainly composed of algae and echinoderm bioclasts). Microfacies in category 9 represents a chert with bafflestone fabric (Pl. 8), characterized by *in-situ* growth of a reef-builder organism (silicified sponge) acting as baffler (trapping sediment). Categories 1 and 7 include three microfacies differentiated on the basis of predominant fossils (whole algae in [07a], Pl. 9, echinoderm fragments in microfacies [07b], Pl. 7, and sponge spicules in [01], Pl. 2) and the mineralogy of bioclasts (carbonate in [07a] and [01], and carbonate fluorapatite in [07b]). Microfacies [08] is characterized by abundant and very well preserved whole calcareous algae, some silicified and some phosphatized, and larger benthic foraminifera (Pl. 9).

Grouping cherts with packstone fabric in two categories was operated based on cement and matrix contents: microfacies in category 10 contain a small amount of remnant carbonate matrix between particles, while microfacies in category 11 contain a small amount of silicified matrix (cryptocrystalline quartz cement). Another differentiating criterion is the content of peloids versus bioclasts: microfacies [10a], [10b] and [11a] are peloidal packstone cherts (Pl. 10), while [11b] exhibits a predominance of both bioclast and peloids (Pl. 11).

Table 4. Chert microfacies silicification intensity*

No.	Chert microfacies	SP vs NsP	SP %	SilCem %	SP+SilCem %	Silicification intensity
12c	peloidal-algal grainstone chert	SP > NsP	45.5	47.5	93.0	Very strong
03	planktonic foraminifera cementstone chert	SP > NsP	6.4	83.3	89.7	Very strong
05b	cementstone chert	SP > NsP	7.2	80.2	87.4	Very strong
05a	cementstone chert	SP = NsP	5.1	80.1	85.2	Very strong
04d	sporadic hole algae-bioclastic cementstone chert	SP > NsP	12.2	72.0	84.3	Very strong
11b	bioclastic-peloidal packstone chert	SP > NsP	60.5	21.0	81.5	Very strong
09	sponge reef chert	SP > NsP	40.0	38.3	78.3	Strong
10b	peloid-echinoderm packstone chert	SP > NsP	46.1	31.4	77.5	Strong
12b	peloidal-bioclastic grainstone chert	SP > NsP	60.5	17.0	77.5	Strong
01	spiculite wackestone chert	SP > NsP	47.5	28.5	76.0	Strong
10a	peloid-algae packstone chert	SP > NsP	55.7	19.3	75.0	Strong
02	radiolarian chert	SP > NsP	50.0	22.5	72.5	Strong
04c	sporadic hole algae-bioclastic cementstone chert	SP < NsP	11.5	60.6	72.2	Strong
04b	bioclastic cementstone chert	SP > NsP	9.3	58.4	67.7	Strong
11a	peloid-echinoderm-algae packstone chert	SP > NsP	45.7	21.8	67.5	Strong
04a	phosphatized bioclastic cementstone chert	SP < NsP	4.2	59.3	63.5	Strong
08	hole algae wackestone chert	SP < NsP	11.9	45.9	57.8	Moderate
07a	sporadic hole algae-bioclastic wackestone chert	SP < NsP	7.0	47.8	54.8	Moderate
12a	peloid-cortoid grainstone chert	SP < NsP	40.5	14.0	54.5	Moderate
07b	phosphatized bioclastic wackestone chert	SP < NsP	5.7	45.5	51.2	Moderate
06a	partially silicified spiculite-peloid wackestone	SP < NsP	14.5	30.2	44.7	Poor
06b	partially silicified bioclastic wackestone	SP < NsP	5.0	37.1	42.1	Poor

* Using the recorded mineralogy of gains, the silicification intensity was determined by summing up the percentage of siliceous particles and the percentage of siliceous cement in each thin section. Four stages of silicification intensity: very strong (above 80%), strong (between 60% and 79.9%), moderate (between 50 and 59.9 %), and poor (under 49.9%). SP – siliceous particles; NsP – non siliceous particles; SP vs. NsP – ratio between SP and NsP; SilCem – siliceous cement.

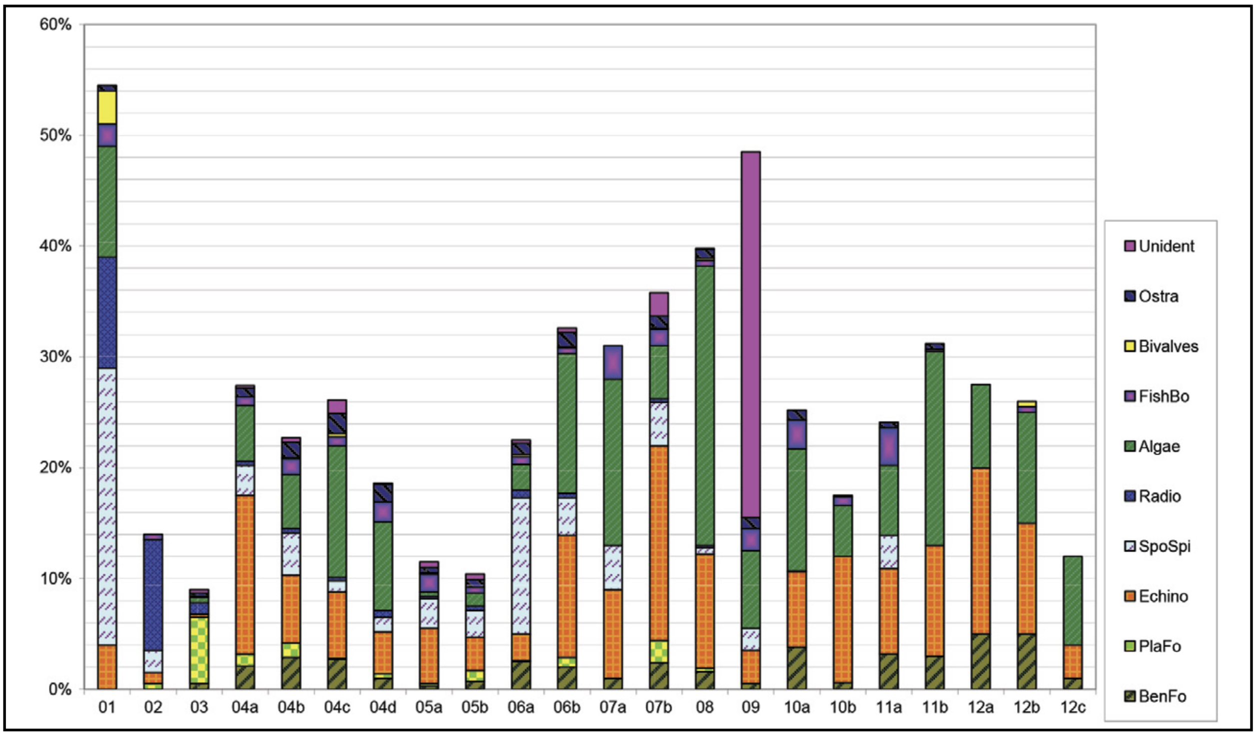

Chart 2. Chert microfacies faunal association: average values were obtained from estimated bioclast composition of individual thin sections assigned to each microfacies (BenFo – benthic foraminifera; PlaFo – planktonic foraminifera; Echino – echinoderms; SpoSpi – sponge spicules; Radio – radiolarians; FishBo – rounded fragments of fish bones; Ostra – ostracods; Unident – unidentified).

Cherts with grainstone fabric were identified in one thin section each, having as distinctive features non-skeletal grain types association, packing and compaction: microfacies [12a] is a compacted and poorly silicified peloid-cortoid gainstone (Pl. 12), [12b] is a very compacted and strongly silicified peloidal grainstone (Pl. 13.1), while [12c] is a laminated, poorly compacted and completely silicified peloidal grainstone (Pl. 13.2).

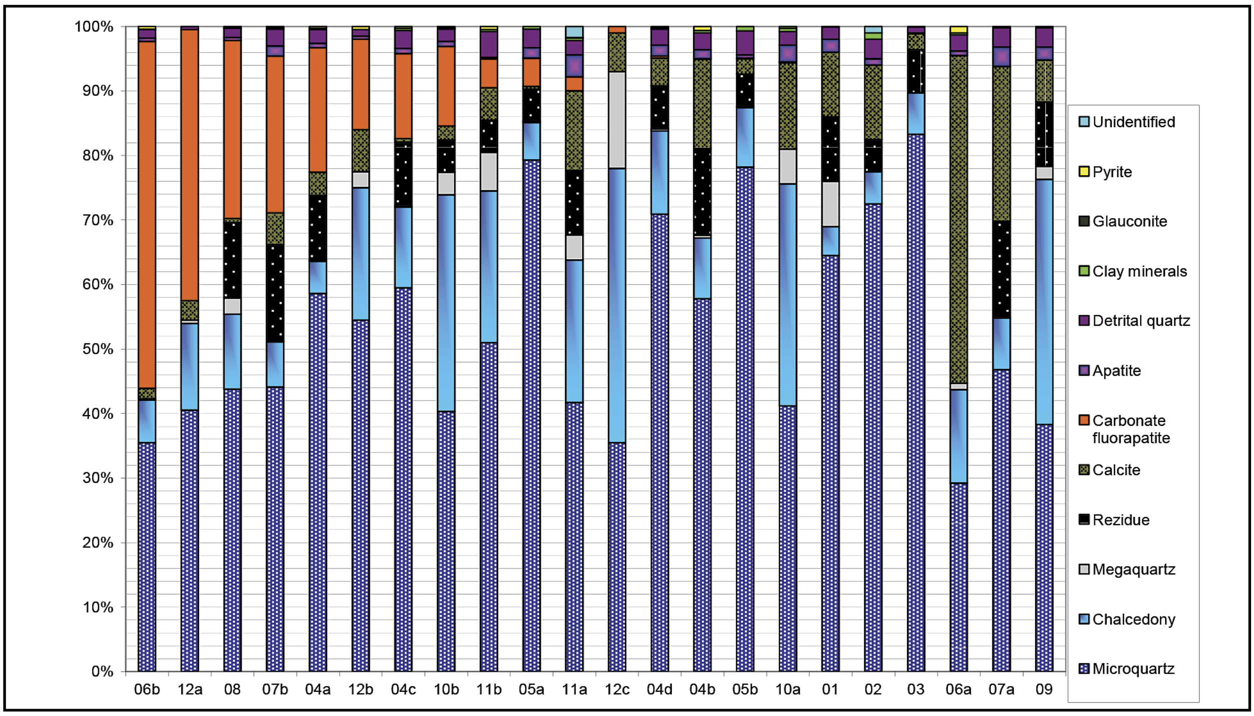

Chart 3. Chert microfacies mineralogy: average values were obtained from estimated mineralogical composition of individual thin sections assigned to each microfacies.

Predominant mineralogical phases in chert microfacies are represented by microquartz and chalcedony (with a few exceptions clearly visible in Chart 3, X-ray diffraction confirmed that quartz is the predominant mineralogical phase), followed by crypto-/microcrystalline carbonate fluorapatite or crypto-/microcrystalline calcite. These two mineral phases separate cherts from all categories in two mineralogical facies: the phosphatic facies including the first 10 microfacies in Chart 3; the calcium carbonate facies containing the other 12 microfacies in Chart 3. Intra- and interparticle cementation by crypto-/microcrystalline carbonate fluorapatite of sediments occurs during interruption of sedimentation (Flügel, 2010: 649).

Evaluation of macroscopic characteristics has confirmed that visual variability exists both between and inside chert microfacies (Pl. 2-13). Some chert microfacies exhibit more than one color, indicating more localized depositional and diagenetic conditions, different contents of non-siliceous and non-carbonate minerals, but also weathering. Different microfacies ([04c], [04d], [05a], [05b]) have the same colors and a mottled aspect that would entitle, from a macroscopic point of view, to consider them as representing a single chert variety. Some hand samples included in microfacies [11a] and [10a] from Giurgiu-Malu Roşu site and Ghizdaru-Haltă Quarry sampling location have a dull brownish shade with very few carbonate relics, which were considered as one chert variety during macroscopic analysis. Microfacies analysis proved that macroscopic examination (especially, color) is not a reliable tool for chert classification.

4.2. Facies Zones, Geological and Geographical Distribution

Microfacies identified in the Lower Danube Valley cherts reveal different depositional settings, grading from restricted platform interior to cratonic basin (Table 5, Pl. 15.2). Cherts from categories 1-8 with mudstone and wackestone depositional fabrics reflect sedimentation in low energy environments and calm waters. The sponge reef chert [09] reflects a shallow-water marine environment and platform-margin reef depositional setting. Through microfossil association and depositional fabric, the whole algae chert [08] mirrors deposition in open shelf lagoon setting and shallow-water marine environment, below wave base (FZ 7). Microfacies included in categories 4-7 were assigned to deep-water marine environments and deep shelf depositional settings (FZ 2) based on mixed benthic and planktonic fauna identified in thin sections, namely different families of agglutinated foraminifera, echinoderms, calcareous algae, pelagic foraminifera, and radiolarians. Microfacies in categories 1-3 were assigned to deep-water marine environment and cratonic basin depositional settings (FZ 1) based on predominant pelagic fauna. Abundance of radiolarians and planktonic foraminifera are typical for standard microfacies in FZ 1.

Some thin sections allow stratigraphic relations to be inferred for microfacies in categories 3-8 (Pl. 15.3): sample Ciup-Ca [10] reveals the vertical transition from microfacies [08] to microfacies [04d]; sample GMR-Ca [02] catches the vertical transition from microfacies [06b] to microfacies [04a]; in sample Văd-MF [23] was observed the transition between microfacies [04a] and [05b]. These samples reveal the fact that the phosphate microfacies (phosphatic chalk) were positioned in the host rock above the calcium carbonate microfacies (chalk and micrite limestones). Microfacies with high bioclast content ([06a], [06b], [07a], [07b], [04a], [04b], and [04c]) are regarded as allochthonous deposits with grains provided from shelf lagoons settings, such as microfacies [08]. This interpretation rests upon similarities between whole algae in microfacies [08] and whole/fragmented algae identified in microfacies from categories 4 to 7. Microfacies with lower bioclast content ([04d], [05a], [05b]) are interpreted as starved allochthonous deposits reflecting changes in sediment influx and water levels. The calcium carbonate facies indicates normal marine carbonate production during the interval of a rising sea level (high stand). The phosphate facies reflects interruption of sedimentation correlated with marine regression (low stand). The geological time of this shoaling-upward sequence is Upper Cretaceous, as suggested by the presence of planktonic foraminifera from *Hedbergellidae* family (family range: Late Aptian to Paleocene), *Globotruncana* Cushman genus (genus range: Late Coniacian to Maastrichtian) and *Heterohelix* Ehrenberg genus (genus range: Late Albian to Maastrichtian) in microfacies from categories 3-7 (Pl. 14).

Geographic distribution of microfacies form categories 1-8 is rather unequal: microfacies [01], [02], and [03] were identified only in Giurgiu area (see Pl. 15.1); categories 4 to 8 have a wide geographical distribution spreading throughout the whole study area (see Pl. 15.1). South of Turnu Măgurele, between Pleven and Nikopol (Bulgaria, see Pl. 15.1), and also between Shumen and Devnya, further South of Giurgiu (not on the map from Pl. 15.1), crops out the Moesian flint. This type of chert has colors ranging from light brown to gray, massive and spotted structure (pale gray spots), with a "micro to cryptocrystalline groundmass and abundance of lightly fragmented and chaotic distributed microfauna" (Gurova and Nachev, 2008: 34). In Upper Campanian chalk, Moesian flint occurs as one meter thick layer of flint nodules. At Ciuperceni-Quarry, the interdisciplinary research coordinated by V. Boroneanţ in the 1980s concluded that ostracods and foraminifera association from the chalk with flints found at the base of the Neogene and Pleistocene deposits indicates the Upper Campanian stage (Boroneanţ *et al.*, 1983: 14-15). Petrographic description of Moesian flint from Gurova and Nachev (2008) and microphotographs they published match some of Ciuperceni-Quarry chert samples in this study (microfacies [04b], [04c], [04d], [05a], [05b]), but this doesn't mean that they have the same age or to be considered as Moesian flint without further analyses.

Depositional fabric of cherts from categories 10-12, together with high content of peloids and constant presence of Miliolid foraminifera, indicate a shallow-water marine en-

Table 5. Classification and Facies Zone distribution of Lower Danube Valley chert microfacies

No.	Classification			Facies Zone	Standard Microfacies	Depositional setting	Marine environment	Age
	in this study (Chert Microfacies)	after Dunham (1962)	after Folk (1962)					
01	spiculite wackestone chert	spiculite wackestone	packed biomicrite	FZ 1	SMF 1	cratonic basin	deep-water	-
02	radiolarian chert	-	-	FZ 1	SMF 3-Rad	cratonic basin	deep-water	-
03	planktonic foraminifera cementstone chert	foraminifera mudstone	fossiliferous micrite	FZ 1	SMF 3-For	cratonic basin	deep-water	K2
04a	phosphatized bioclastic cementstone chert	bioclastic wackestone	sparse biomicrite	FZ 2	-	deep shelf	deep-water	K2
04b	bioclastic cementstone chert	bioclastic wackestone	sparse biomicrite	FZ 2	-	deep shelf	deep-water	K2
04c	sporadic whole algae-bioclastic cementstone chert	bioclastic wackestone	sparse biomicrite	FZ 2	-	deep shelf	deep-water	K2
04d	sporadic whole algae-bioclastic cementstone chert	bioclastic wackestone	sparse biomicrite	FZ 2	-	deep shelf	deep-water	K2
05a	cementstone chert	bioclastic wackestone	sparse biomicrite	FZ 2	-	deep shelf	deep-water	K2
05b	cementstone chert	bioclastic wackestone	sparse biomicrite	FZ 2	-	deep shelf	deep-water	K2
06a	partially silicified spiculite-peloid wackestone	spiculitic-peloidal wackestone	sparse bio-pelmicrite	FZ 2	-	deep shelf	deep-water	K2
06b	partially silicified bioclastic wackestone	bioclastic wackestone	sparse biomicrite	FZ 2	-	deep shelf	deep-water	K2
07a	sporadic whole algae-bioclastic wackestone chert	bioclastic wackestone	sparse biomicrite	FZ 2	-	deep shelf	deep-water	K2
07b	phosphatized bioclastic wackestone chert	bioclastic wackestone	sparse biomicrite	FZ 2	-	deep shelf	deep-water	K2
08	whole algae wackestone chert	algal wackestone	sparse biomicrite	FZ 7	SMF 8	open shelf lagoon	shallow-water	K2
09	sponge reef chert	boundstone	Biolithite	FZ 5	SMF 7-Bafflestone	platform-margin reefs	shallow-water	-
10a	peloid-algae packstone chert	peloidal packstone	poorly washed pelsparite	FZ 8	SMF 16-Non-laminated	restricted platform interior	shallow-water	-
10b	peloid-echinoderm packstone chert	peloidal packstone	poorly washed pelsparite	FZ 8	SMF 16-Non-laminated	restricted platform interior	shallow-water	-
11a	peloid-echinoderm-algae packstone chert	peloidal packstone	poorly washed pelsparite	FZ 8	SMF 16-Non-laminated	restricted platform interior	shallow-water	-
11b	bioclastic-peloidal packstone chert	bioclastic packstone	poorly washed bio-pelsparite	FZ 8	SMF 16-Non-laminated	restricted platform interior	shallow-water	-
12a	peloid-cortoid grainstone chert	peloidal grainstone	Pelsparite	FZ 8	SMF 16-Non-laminated	restricted platform interior	shallow-water	-
12b	peloidal-bioclastic grainstone chert	peloidal grainstone	Pelsparite	FZ 8	SMF 16-Non-laminated	restricted platform interior	shallow-water	-
12c	peloidal-algal grainstone chert	peloidal grainstone	Pelsparite	FZ 8	SMF 16-Non-laminated	restricted platform interior	shallow-water	-

vironment and a restricted platform interior depositional setting (Facies Zone 8). Cherts with packstone fabric reflect sedimentation both in agitated and calm waters, whereas grainstones mirror deposition in high energy environments with fast accumulation, in current-controlled environments. No vertical relations between these microfacies were observed in thin sections or could be established otherwise.

Peloidal cherts have a very restricted geographical distribution, more specifically the area around Giurgiu (Pl. 15.1), south of which Ludogorie flint crops out. Gurova and Nachev (2008: 33-34) described two petrographic distinct types of Ludogorie flint (Lower Cretaceous): type Ravno with a "cryptocrystalline groundmass" and sponge spicules (between Topchii, Kamenovo, Ravno, Koubrat, Tetovo and Chereshovo), closer in macroscopic aspect to Moesian flint; type Kriva Reka with "microcrystalline aggregates" and "recrystallized chalcedony" (between Goliam Porovets, Drianovets, Krivina, and Chukata near Razgrad), which could be considered as a likely candidate for the peloidal cherts. Given the scarce microscopic analysis (Gurova and Nachev, 2008), peloidal cherts from this study can't be linked to Ludogorie flint types without further analyses.

5. UPPER PALAEOLITHIC CHERT VARIETIES AND SUPPLY SOURCES

The full archaeological implications of this study remain to be detailed elsewhere, but some general remarks about raw-materials, source types and raw-material procurement territories have to be put forward. All criteria used for determining chert microfacies represent at the same time attributes for characterizing and classifying chert varieties from archaeological sites and from possible raw-material sources. Macroscopic characteristic were used to differentiate subvarieties of the same chert microfacies. Identification of chert microfacies both in Palaeolithic sites and sampling locations, meeting also the macroscopic requirements for a positive match, implies that sampled gravel deposits represent plausible Palaeolithic raw-material sources. The present study does not include estimates regarding amounts of each chert variety in lithic assemblages from Upper Palaeolithic sites.

5.1. Chert Varieties and Provenance

Chert varieties differentiated through microfacies analysis for Vădastra-Măgura Fetelor site (Table 6) were considered in previous raw-material determinations either as grayish or brownish chalcedony (Protopopescu-Pache and Mateescu, 1959: 9-10; Mateescu, 1970: 69) or as Cretaceous flint (Păunescu, 2000: 223, 232). During field surveys in vicinity of the site (Obârşia River) and along Danube's lower terrace (between Orlea and Grojdibod, Pl. 1) no viable sampling location were recognized, and in consequence provenance of these chert varieties remains to be established. External characteristics of samples analyzed and microfissures observed under microscope point out towards a raw-material source similar in composition (variability, availability, nodule size and shapes, cortex features) to Ciuperceni-Quarry, but with a distinct physiographic position and situated at about 10-20 km North-East from the site. This is in accordance with Tuffreau *et al.* (2014: 298), who consider that Vădastra-Măgura Fetelor is not a flint-knapping site associated with extraction/gathering of raw-materials from nearby sources, but a multifunctional open-air site.

All chert varieties from Ciuperceni-La Tir and Ciuperceni-La Vii sites were identified in the sampling location Ciuperceni-Quarry (Table 6), a modern nearby abandoned quarry opening Frăteşti Formation conglomerate deposit (Lower Pleistocene alluvial fan deposits, Table 1, Pl. 1 and 15). Both Palaeolithic sites are located in direct proximity of the raw-material supply source, raw-materials being transported on short to very short distances, as indicated by the volume and size of the unprepared chert blocks observed in the lithic assemblages (Tuffreau *et al.*, 2014: 291). The use of many varieties reflects variability and richness of the source itself, and maybe lack of differences between these varieties for Palaeolithic people. Ciuperceni-Quarry offers a good perspective on chert abundance, availability and variability around the Palaeolithic sites of Ciuperceni.

Analysis of Giurgiu-Malu Roşu samples proved the existence of two main groups of cherts: peloidal cherts, with varieties of colors ranging from grayish to brownish (see Table 6); bioclastic chert with varieties' colors going from grayish to brownish (see Table 6). Microfacies analysis provided solid evidence to challenge previously established chert varieties based on color difference: "silex A" category including all granulated gray flint pieces, "silex M" category (also called "Frăteşti type flint") accounting for all brownish flint pieces, and the "fine-grained gray flint" including finer grayish flint pieces (Alexandrescu, 1996-1998; Păunescu, 2000; Alexandrescu *et al.*, 2004; Alexandrescu *et al.*, 2007). Some varieties of brownish peloidal cherts and some grayish and brownish bioclastic cherts from Giurgiu-Malu Roşu originate from gravels of Frăteşti Formation, opened by modern quarries to North-West (Ghizdaru-Haltă Quarry), and from gravels of lower terrace (t_1), opened in places such as Giurgiu-South-West Quarry and Giurgiu-Malu Roşu Quarry. The dull finely dotted dark gray peloid-echinoderm packstone chert corresponds to "bluish tainted, finely dotted, gray granulated flint" (Nicolăescu-Plopşor *et al.*, 1956: 225; Păunescu *et al.*, 1962: 130-131; Păunescu *et al.*, 1964: 109; Păunescu, 2000: 276), representing around 70-85% of the raw-material at Giurgiu-Malu Roşu. This variety was not identified in any of the sampling locations. Preponderance inside the lithic assemblage, size of tested nodules and cores, and cortex features allows anticipating transport distances less than 50 km and a raw-material supply source similar to Frăteşti Formation, that contains a large quantity of grayish peloidal cherts (probably on the other side of the Danube). The Palaeolithic people of Giurgiu-Malu Roşu exploited at least three different supply sources, all within a radius of 50 km (local sources).

After Păunescu and Alexandrescu (1997: 62), the main raw-material at Nicolae Bălcescu-La Vii is represented (in proportion of 95%) by brown, dark brown and brownish-gray Senonian flint (corresponding in this study with the first three varieties determined for this site, Table 6), missing South of the study area (in North-East Bulgaria). External characteristics of Nicolae Bălcescu-La Vii samples ("fresh cortex" with water transport features) imply that the raw-material source is also an alluvial deposit, not far from limestone deposits with chert in primary position. Absence of peloidal cherts at Căscioarele-East side of the Lake could suggest that peloidal chert varieties from Nicolae Bălcescu-La Vii (two varieties, Table 6) were brought in from alluvial deposits near the site (but unidentified by previous researches) or from sources located on the other side of Danube. Lack of field surveys for nearby sampling locations and inconsistent connections with samples from Căscioarele-East side of the Lake (Table 1) or other sampling locations in the study, represent conditions that impair raw-material provenance for this site.

5.2. Chert Sources and Supply Strategies

Chert sources identified on Lower Danube Valley are represented by two types of geological deposits: conglomerates/gravels of Frăteşti Formation (Ciuperceni-Quarry, Ghizdaru-Haltă Quarry) and Danube's lower terrace (t_1) gravel deposits (Giurgiu-South West Quarry and Giurgiu-Malu Roşu Quarry). Frăteşti Formation is characterized by chert nodules from a few centimeters to 20-30 cm, relatively intact, very well preserved cortex with water transport marks (indicating short transport distances). Danube's lower terrace contains rather small chert nodules (around 10-13 cm long) with greatly transformed cortex by water-transport (indicating recycling from older alluvial deposits). These two distinct geological deposits represent allochthonous sources (*sensu* Turq, 2000a: 106-107; 2000b: 391) with high chert variability (different varieties and subvarieties), availability (variable sizes and shapes of chert nodules) and quantity (Ciuperceni and Ghizdaru quarries are chert heavens).

Visual estimation of chert varieties proportions in Ciuperceni-La Vii lithic assemblage points towards equal predominance of beige-cream partially silicified spiculite-peloid wackestone (microfacies [06a]), grayish-brown phosphatized bioclastic wackestone chert (microfacies [07b]), and mottled yellowish-brown bioclastic cementstone chert (microfacies [04b]). These cherts have a rather low silicification degree (see Table 4), with a high content of carbonate. The same chert varieties predominance is also observed in the sampling location. Thus, it can be stated that raw-material choice was constrained by availability, rather than about suitability for knapping or other physical properties of these chert varieties.

Overwhelming predominance of "bluish tainted, finely dotted, gray granulated flint" and use of many other chert varieties at Giurgiu-Malu Roşu, implies that the raw-material supply strategy wasn't just a reflection of chert availability. Supply strategy was controlled by more than one constraint, such as: source accessibility, transport distance and raw-material quality. The low quantity of fine-grained cherts inside the lithic assemblage supplied from gravels of Danube's lower terrace implies that this source probably was sporadically exploited (and probably sporadically available), in spite of the fact that it's the closest source used. Proportion within the lithic assemblage of fine-grained and coarse-grained (peloidal) cherts supplied by gravels of Frăteşti Formation reflects the possibility that this source was further away and less accessible than the source of the main raw-material employed at Malu Roşu.

By comparing chert varieties introduced in Malu Roşu site from Frăteşti Formation gravels it can be concluded that peloidal cherts were favored against the fine-grained varieties well represented in this source. Based on petrographic characteristics and knapping technology, Alexandrescu and Soare (2009) considered the main raw-material ("silex A") from Giurgiu-Malu Roşu of low-quality for knapping, while "silex M" (fine-grained chert) was considered to be of better quality. Braun *et al.* (2009) showed that another factor in raw-material selection is durability, arguing that coarse-grained lithologies (with high content of silica) maintain an active cutting edge for a longer time. Preferential use of peloidal cherts at Malu Roşu could be explained, beside their general abundance in the area, in relation with edge durability.

Regarding raw-material supply strategies, this analysis has revealed two models: *Ciuperceni model*, where Ciuperceni-La Tir and Ciuperceni-La Vii 1 sites are located on the raw-material supply source (alluvial deposit), that covers all chert varieties from the Palaeolithic sites, minimum transport distances (Table 1) and raw-material preference constrained by availability; *Giurgiu model*, where Giurgiu-Malu Roşu site exploited at least three different local sources (under 50 km) covering most chert varieties within the lithic assemblage, transport distances for known sources (alluvial deposits) being around 10 km, and raw-material preference was constrained by source availability and accessibility, transport distance and raw-material quality.

6. CONCLUSIONS

The objective of the study wasn't to test a new or innovative investigation tool for prehistoric raw-material provenance (microfacies analysis is an old method in geology, Flügel, 2010: 1), but an attempt to more deeply understand the composition of cherts. The present study falls short from using quantitative microscope techniques (point-counting of grains and statistical modeling), complementary techniques such as SEM, cathodoluminescence microscopy, and geochemical techniques. Another drawback is the unspecialized determinations of fossils carried out in this study, determinations that might have a great potential in microfacies analysis.

Table 6. Upper Palaeolithic chert varieties and provenance established through microfacies analysis

Archaeological samples*	Chert variety	Matching samples from geological deposits**
Văd-MF [26], Văd-MF [29]	mottled brownish phosphatized bioclastic cementstone chert [04a]	-
Văd-MF [69], Văd-MF [70]	mottled yellowish-brown phosphatized bioclastic cementstone chert [04a]	-
Văd-MF [23]	dotted dark gray phosphatized bioclastic cementstone chert [04a]	-
Văd-MF [03]	chocolate brownish cementstone chert [05b]	-
Văd-MF [44]	gray-brownish partially silicified bioclastic wackestone [06b]	-
Ciup-Tir [10], Ciup-Tir [16]; Ciup-Vii [07], Ciup-Vii [06], Ciup-Vii [05a], Ciup-Vii [05b]	beige-cream partially silicified spiculite-peloid wackestone [06a]	Ciup-Ca [22], Ciup-Ca [3], Ciup-Ca [7], Ciup-Ca [8], Ciup-Ca [1]
Ciup-Tir [08]; Ciup-Vii [01]	clear grayish-brown sporadic whole algae-bioclastic cementstone chert [04d]	Ciup-Ca [24], Ciup-Ca [21], Ciup-Ca [12]
Ciup-Tir [7], Ciup-Tir [11]; Ciup-Vii [03]	mottled yellowish-brown bioclastic cementstone chert [04b]	Ciup-Ca [2], Ciup-Ca [9], Ciup-Ca [11]
Ciup-Vii [04]	mottled dark gray phosphatized bioclastic cementstone chert [04a]	Ciup-Ca [6], Ciup-Ca [14], Ciup-Ca [16], Ciup-Ca [19]
Ciup-Vii [02]	grayish-brown phosphatized bioclastic wackestone chert [07b]	Ciup-Ca [5], Ciup-Ca [15], Ciup-Ca [23]
GMR [30]	clear light gray peloid-echinoderm packstone chert [10b]	-
GMR [40]	clear pinkish peloid-echinoderm packstone chert [10b]	-
GMR [10], GMR [22], GMR [102]	dull finely dotted gray peloid-echinoderm packstone chert [10b]	-
GMR [20]	bluish-dark gray peloidal-bioclastic grainstone chert [12b]	-
GMR [48]	rusty brownish peloid-algae packstone chert [10a]	Gh-CH [5], Gh-CH [6], Gh-CH [15], Gh-CH [18]
GMR [50]	rusty brownish peloid-echinoderm-algae packstone chert [11a]	Gh-CH [4]
GMR [45]	pinkish-gray peloid-echinoderm-algae packstone chert [11a]	Gh-CH [3]
GMR [56]	reddish-dark brown bioclastic-peloidal packstone chert [11b]	-
GMR [43]	laminated yellowish-brown peloidal-algal grainstone chert [12c]	-
GMR [75], GMR [86]	gray whole algae wackestone chert [08]	Giur-Ca [2], Giur-Ca [3]

Table 6 (continued)

Archaeological samples*	Chert variety	Matching samples from geological deposits**
GMR [58], GMR [59]	clear light gray-brown sporadic whole algae-bioclastic cementstone chert [04c]	GMR-Ca [3]
GMR [60]	clear brownish sporadic whole algae-bioclastic cementstone chert [04d]	-
GMR [77]	dull brownish partially silicified bioclastic wackestone [06b]	-
GMR [61], GMR [85]	light to dark gray phosphatized bioclastic wackestone chert [07b]	-
GMR [39]	clear light gray phosphatized bioclastic cementstone chert [04a]	-
GMR [73]	mottled yellowish-brown phosphatized bioclastic cementstone chert [04a]	GMR-Ca [1]
GMR [62]	mottled clear yellowish-brown cementstone chert [05a]	-
GMR [65]	mottled clear brown cementstone chert [05b]	Gh-CH [1], Gh-CH [11]
GMR [88]	clear yellowish-brown planktonic foraminifera cementstone chert [03]	-
GMR [98]	clear gray-pinkish planktonic foraminifera cementstone chert [03]	-
GMR [96]	clear gray planktonic foraminifera cementstone chert [03]	
NB-Vii [25]	mottled dark gray phosphatized bioclastic cementstone chert [04a]	-
NB-Vii [16]	blackish phosphatized bioclastic cementstone chert [04a]	-
NB-Vii [02]	clear brown cementstone chert [05a]	-
NB-Vii [21]	greenish-gray partially silicified bioclastic wackestone [06b]	-
NB-Vii [10]	brown peloid-echinoderm-algae packstone chert [11a]	-
NB-Vii [18]	blackish bioclastic-peloidal packstone chert [11b]	-

* Văd-MF - Vădastra-Măgura Fetelor; Ciup-Tir - Ciuperceni-La Tir ; Ciup-Vii - Ciuperceni-La Vii 1; GMR - Giurgiu-Malu Roşu; NB-Vii - Nicolae Bălcescu-La Vii.
** Ciup-Ca - Ciuperceni-Quarry; Gh-CH - Ghizdaru-Haltă Quarry; Giur-Ca - Giurgiu-South West Quarry; GMR-Ca - Giurgiu-Malu Roşu Quarry.

This study was conducted on a limited number of thin sections of chert in secondary positions and archaeological context, lacking samples collected from cherts in primary position together with samples of host-rock. These chert microfacies are provisory and will undergo inherent modifications as a result of future investigations, but this doesn't influence validity of the investigation method. Future research of Lower Danube Valley cherts has to be directed on expanding the study area to S (Bulgaria) and SE (Dobrogea), systematic sampling of secondary and primary deposits, microfacies analysis of flint types from Bulgaria, and last, but not least, using all the above techniques for refining and calibrating chert microfacies.

This microfacies analysis delivered the means to characterize and classify cherts (22 chert microfacies), while sedimentary interpretations of microfacies strengthened and supported them as valid chert varieties, that reflect local conditions in a regional geological setting (a rimmed carbonate platform with localized sedimentation conditions inside each Facies Zones). From archaeological point of view, microfacies analysis represents a basic geological investigation tool used to sneak a look at raw-materials provenance and supply strategies in the Upper Palaeolithic from Lower Danube Valley. This study demonstrated that raw-materials were inadequately characterized and too broadly defined (each site contains more chert varieties than previously was established). Also, this analysis has verified and confirmed older hypotheses about local alluvial deposits (Frăteşti Formation and Danube terrace deposits) as supply sources for some of the Upper Palaeolithic sites.

Chert categories defined in this study (bioclastic and peloidal cherts), together with their geographic spreading in the study area, mirror distribution of Moesian flint and Ludogorie Flint in Bulgaria. As it was proved here, these categories include many different chert varieties. This suggest that regionally defined chert types (such as Moesian Flint, Ludogorie Flint, Balkan Flint) should be reevaluated and fragmented into types, subtypes, varieties, and subvarieties based on criteria others than those used before. Chert variety names such as Ludogorie Flint, Moesian Flint, Oltenian Flint, Balkan Flint and so forth encompass materials with large areas of distribution in primary (and secondary) deposits and localized sedimentological and diagenetic conditions, expressed as distinctive petrographic and/or geochemical traits, that go beyond their similar/distinctive macroscopic characteristics (such as the color and macroscopic aspect of Balkan flint "easily recognized" by archaeologists), as it was confirmed by geochemical analyses in Bulgaria and the results of this study.

Inferences regarding supply sources resulted from positive identification (based on current criteria) of archaeological samples with regionally defined types of cherts (combined with insufficient field surveys for possible supply sources) encourage farfetched suppositions about transport distances and exchange routs. Regionally defined chert names have a general signification and they shouldn't be used to indicate provenance or raw-material characteristics.

ACKNOWLEDGMENTS

This research was carried out as part of one of the authors PhD program (Ciornei Alexandru) at the Faculty of Geology, University of Bucharest (2009-2013). This author has a long list of persons to be grateful and thankful to, the short version starting with: professor Lucian Matei (Mineralogy professor at Faculty of Geology, University of Bucharest), for his guidance and coordination of my PhD thesis; Roxana Dobrescu (head of Palaeolithic department, "Vasile Pârvan" Institute of Archaeology, Bucharest), for permission to sample artifact collections of the Upper Palaeolithic sites in this study; Sorin Oanţă-Marghitu (archaeologist at National History Museum of Romania), for reading different versions of my PhD thesis; Mihai Tudose, for his support in field surveys. Not to forget, I am deeply indebted to my family for their encouragement and financial support.

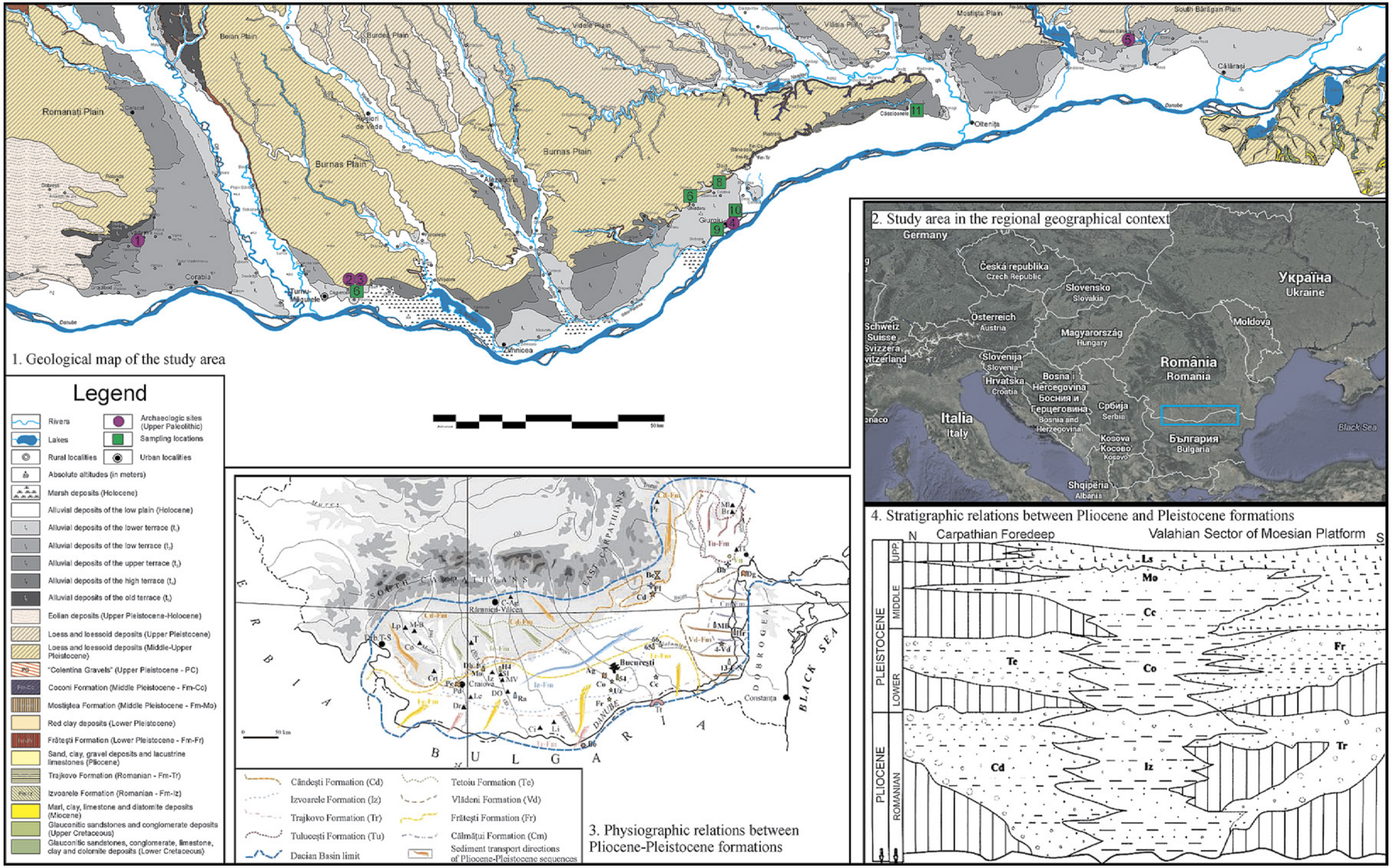

Plate 1. Lower Danube Valley study area: **1**. Geological map of the study area with the position of archaeological sites (**1**. Vădastra-Măgura Fetelor, **2**. Ciuperceni-La Tir, **3**. Ciuperceni-La Vii, **4**. Giurgiu-Malu Roşu, **5**. Nicolae Bălcescu-La Vii) and sampling locations (**6**. Ciuperceni-Quarry, **7**. Ghizdaru-Haltă Quarry, **8**. Cetatea-Bălănoaia Quarry, **9**. Giurgiu-South-West Quarry, **10**. Giurgiu-Malu Roşu Quarry, **11**. Căscioarele-East side of the Lake); Digital map redrawn after Geological Map of Romania 1: 200000 (1966-1968), Sheets Turnu Măgurele, Slatina (lower part of the sheet), Neajlov (lower part of the sheet), Giurgiu, Bucureşti and Călăraşi (lower part of the sheet), with modification regarding names and chronostratigraphy of Pliocene and Pleistocene formations (after Andreescu *et al.*, 2011); **2**. Study area in the regional geographical context (blue rectangle); **3**. Physiographic relations between Pliocene and Pleistocene formations in the Dacian Basin (after Andreescu *et al.*, 2011: 199, with modifications); **4**. Stratigraphic relations between Pliocene and Pleistocene formations (after Andreescu *et al.*, 2011: 200, with modifications) - Ls - Loess deposits; Mo - Mostiştea Formation; CC - Coconi Formation; Te - Tetoiu Formation; Co - Copăceni Beds; Fr - Frăteşti Formation; Cd - Cândeşti Formation; Iz - Izvoarele Formation; Tr - Trajkovo Formation.

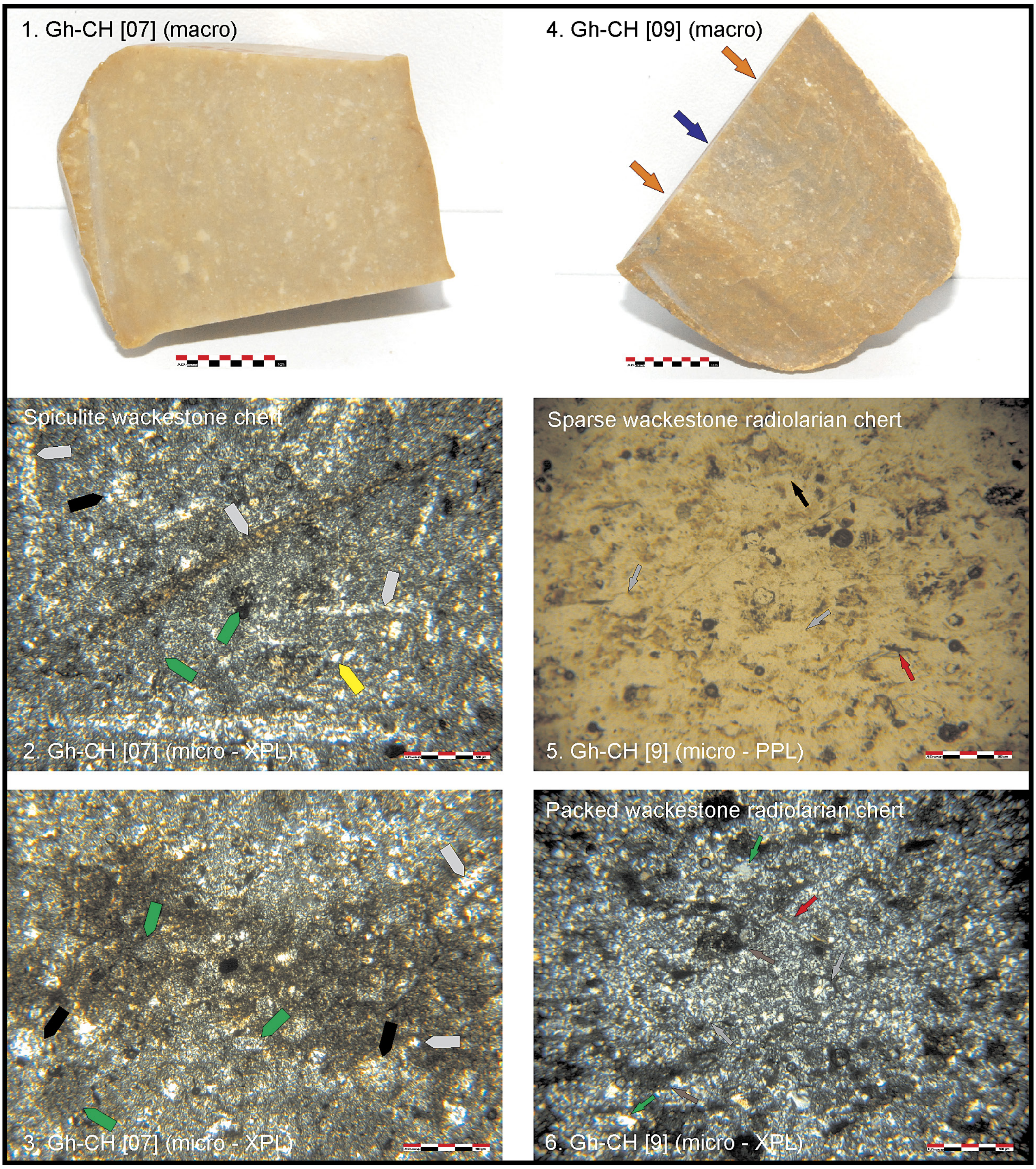

Plate 2. 1-3. Spiculite wackestone chert [01] (FZ 1, cratonic basin): translucent, light brown color with beige oval millimeter sized spots, greasy luster; packed wackestone fabric consisting of sponge spicules (gray arrows), radiolarians (black arrows), peloids (green arrows), quartz grainclasts (yellow arrow), silicified micrite matrix; bioclasts are completely or partially silicified (microcrystalline quartz, chalcedony), some of them passing through a mold stage; **4-6**. Radiolarian chert [02] (SMF 3-Rad, FZ 1, cratonic basin): translucent, light brownish color, dull, with lamination pattern, clear gray-brownish (blue arrow) and brown-rusty (orange arrows) laminae; at the microscope, the lamination pattern is revealed as an alternation of sparse wackestone fabric (orange arrows) and packed wackestone fabric (blue arrow), with radiolarians (gray arrows), sponge spicules (black arrows), peloids (brown arrows), high siliciclastic input of quartz (green arrows) and clay grainclasts (red arrows); slow sedimentation rate, parallel orientated particles (especially clay minerals); strongly compacted and recrystallized radiolarians and sponge spicules (initially composed of opal-A, transformed in microquartz) embedded in a recrystallized siliceous ooze (xenotopic inequigranular microcrystalline quartz); macro photos - scales are 1 cm; micro photos - scales are 500 µm; XPL - cross-polarized light; PPL - plane-polarized light; photos by Al. Ciornei (2012-2013).

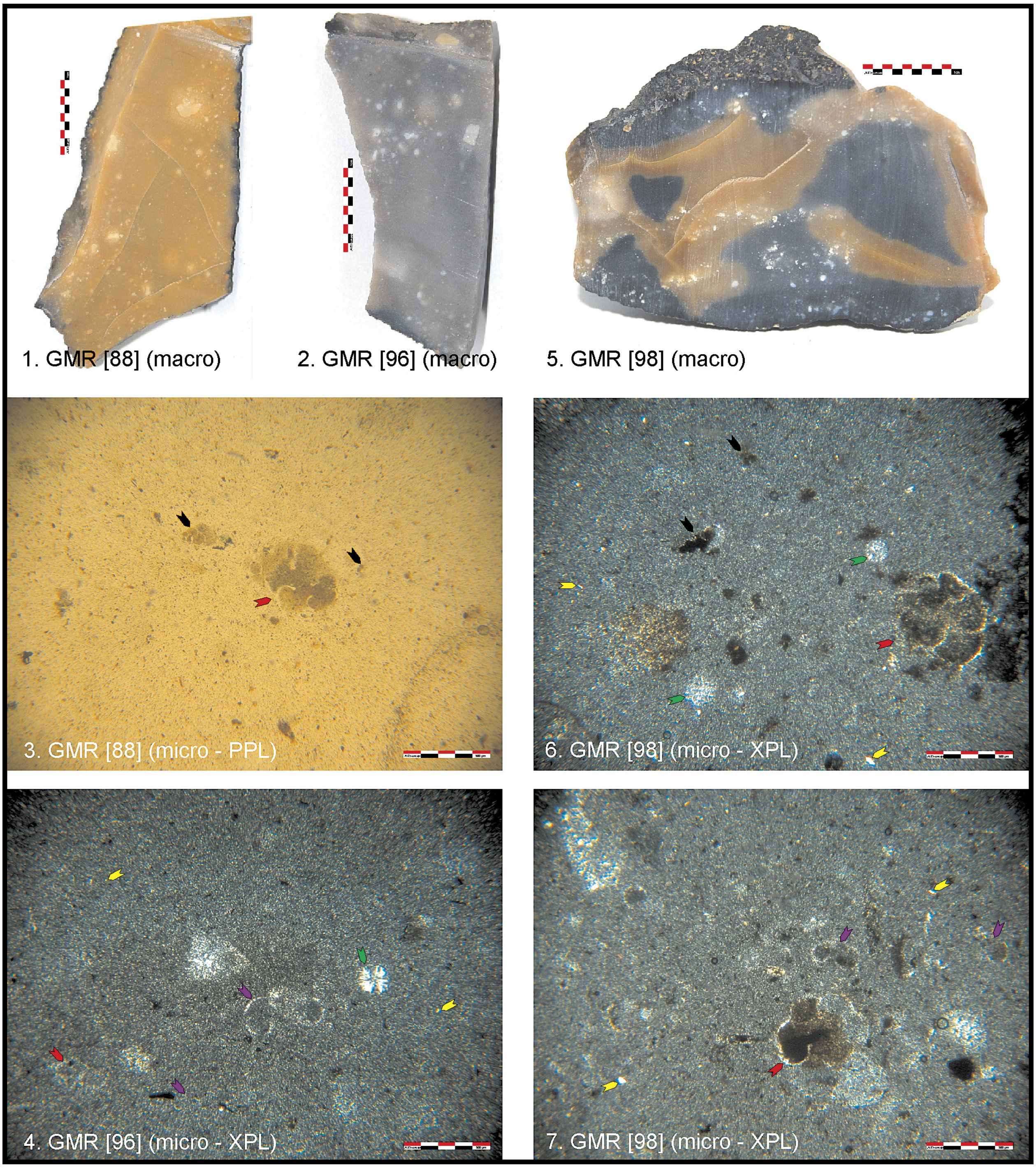

Plate 3. Planktonic foraminifera cementstone chert [03] (SMF 3-For, FZ 1, cratonic basin): from yellowish-brown, gray-yellowish, gray to gray-rosy and pinkish, vitreous luster, translucent, sporadically dotted (grayish-white point-like, millimeter sized, carbonate relics); mudstone fabric (fossiliferous micrite) with widely spread plancktonic and benthic foraminifera, radiolarians (green arrows), sporadic very fine-grained echinoderm and algae bioclast, and a low quantity of quartz grainclasts (yellow arrows); the micrite matrix was almost entirely replaced by cryptocrystalline quartz (cementstone); the characteristic planktonic foraminifera association is represented by *Heterohelix* Ehrenberg (black arrows), *Globotruncana* Cushman genus (red arrows) and *Hedbergellidae* family (purple arrows); macro photos - scales are 1 cm; micro photos - scales are 500 µm; XPL - cross-polarized light; PPL - plane-polarized light; photos by Al. Ciornei (2013).

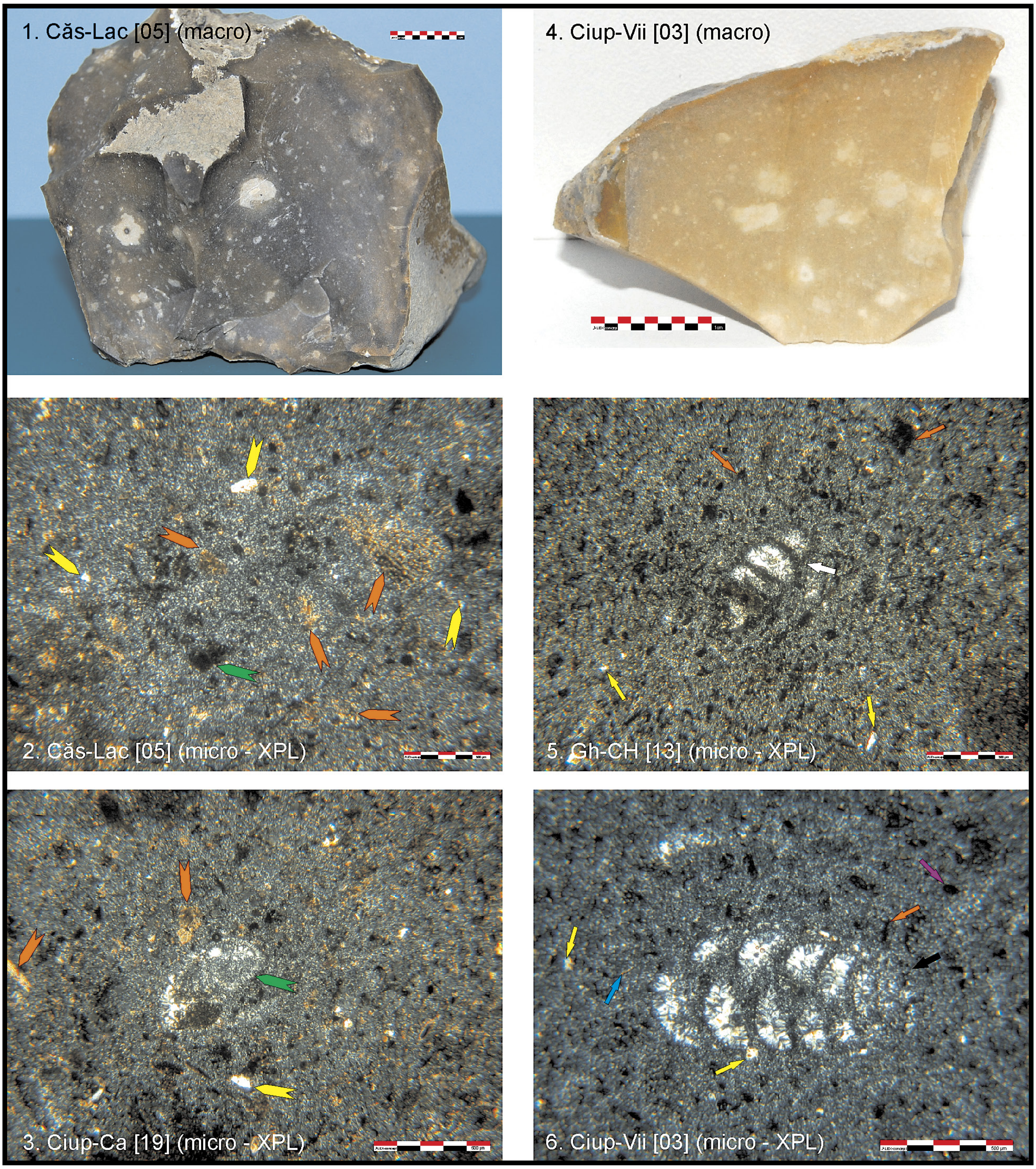

Plate 4. 1-3. Phosphatized bioclastic cementstone chert [04a] (FZ 2, deep shelf): from gray, grayish-brown to yellowish-brown, greasy luster, translucent, mottled by grayish-white point-like, oval and/or irregular, millimeter sized, carbonate relics; sparse wackestone fabric with fine-grained echinoderm and algae fragments (orange arrows), sponge spicules, agglutinated benthic and planktonic foraminifera (green arrows), sporadic radiolarians; bioclasts are held together by the siliceous cement (cryptocrystalline quartz) which replaced the matrix; very low content of quartz (yellow arrows) and clay grainclasts; **4-6**. Bioclastic cementstone chert [04b] (FZ 2, deep shelf): from yellowish-brown to grayish-light brown, dull, semi-opaque, mottled (white-light gray point-like, oval and irregular, millimeter sized, carbonate relics); sparse wackestone with a silicified micrite matrix (cryptocrystalline quartz), very fragmented echinoderm bioclasts (orange arrows), algae fragments, sporadic peloids (purple arrows), agglutinated benthic (white arrow) and planktonic foraminifera, quartz (yellow arrows) and clay (blue arrow) grainclasts; macro photos - scale are 1 cm; micro photos - scales are 500 µm; XPL - cross-polarized light; photos by Al. Ciornei (2012-2013).

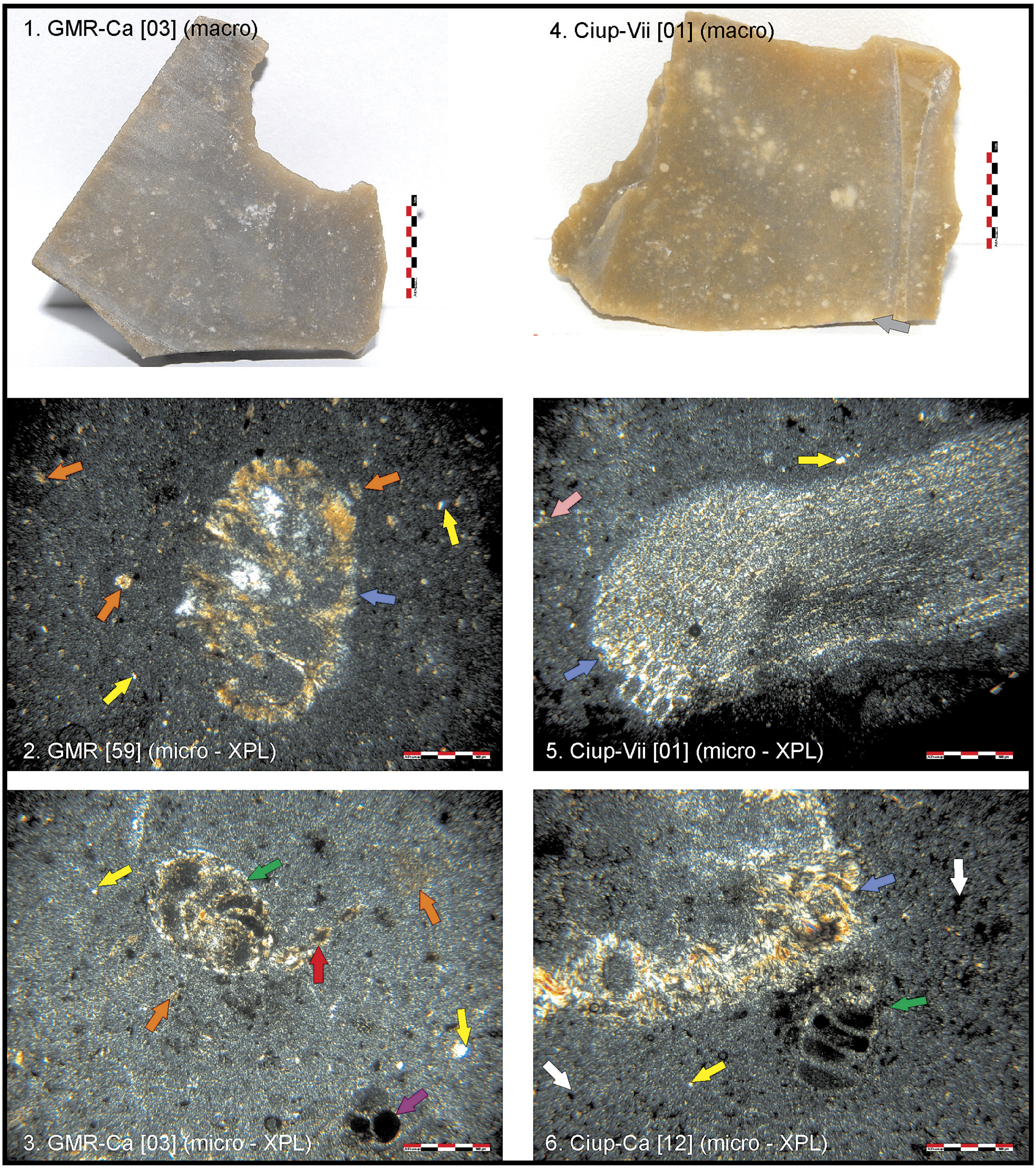

Plate 5. 1-3. Sporadic whole algae-bioclastic cementstone chert [04c] (FZ 2, deep shelf): from clear light gray to clear light brown, spotted (light gray point-like and oval, millimeter sized, carbonate relics), greasy luster, translucent; sparse wackestone depositional fabric with rare whole algae, some of them phosphatized (blue arrow) and some silicified, phosphatized bioclasts of echinoderms (orange arrows) and algae (red arrow), quartz grainclasts (yellow arrows), agglutinated benthic foraminifera (green arrows) and planktonic foraminifera (purple arrow) in a micrite matrix (almost completely silicified - cryptocrystalline quartz); **4-6**. Sporadic whole algae-bioclastic cementstone chert [04d] (FZ 2, deep shelf): from clear grayish-brown to clear light brown, spotted (light gray point-like and oval, millimeter sized, carbonate relics), greasy luster, translucent; sparse wackestone depositional fabric with rare whole algae (blue arrows in microscope photos, and gray arrow in macrosopic photo), micrite bioclasts (white arrows) and silicified bioclasts (pink arrows), quartz grainclasts (yellow arrows), agglutinated benthic foraminifera (green arrows) and planktonic foraminifera floating in a micrite matrix (almost completely silicified - cryptocrystalline quartz); macro photos - scale are 1 cm; micro photos - scales are 500 µm; XPL - cross-polarized light; photos by Al. Ciornei (2012-2013).

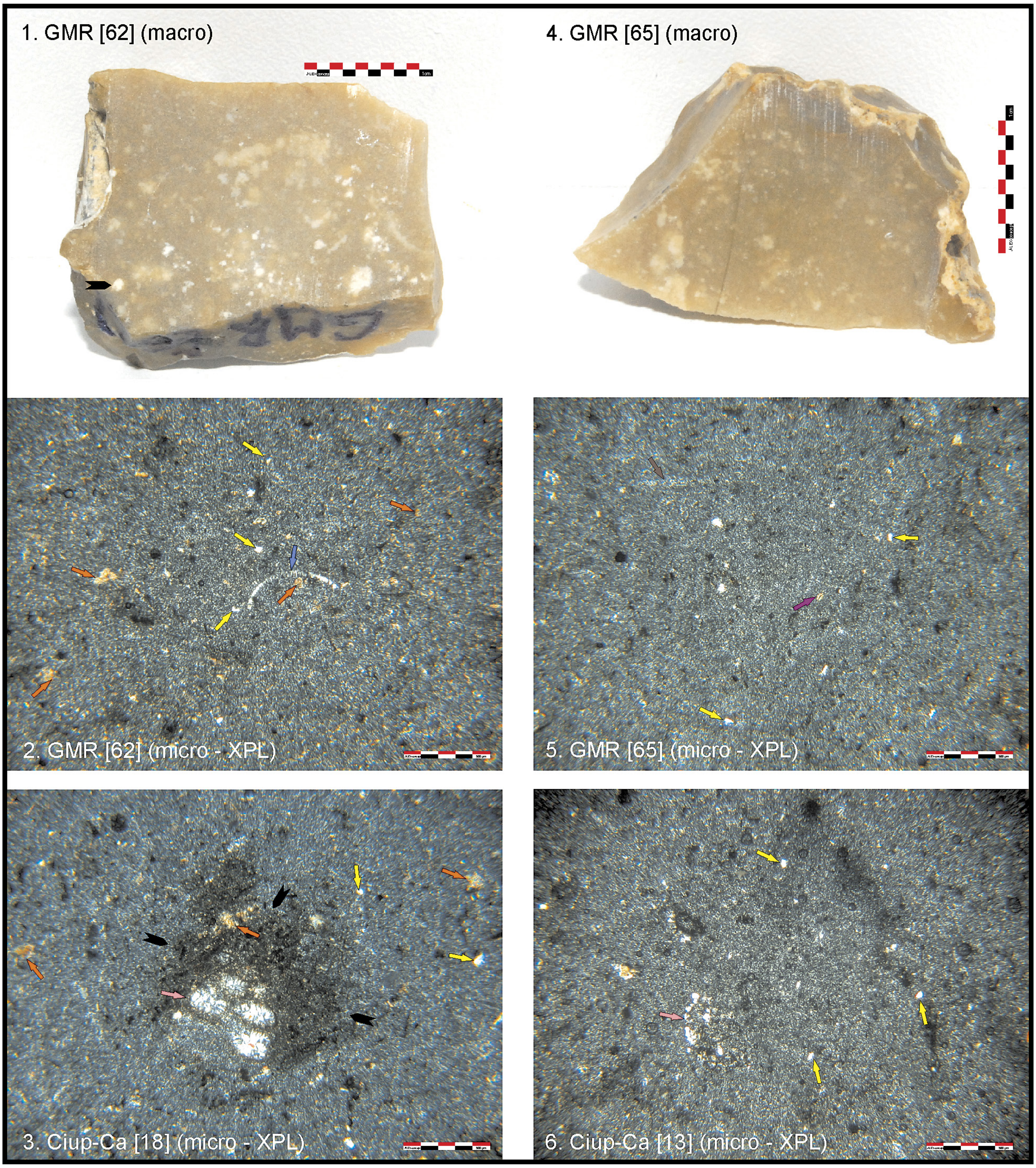

Plate 6. 1-3. Cementstone chert [05a] (FZ 2, deep shelf): from clear grayish-brown to clear dark gray, grayish-white point-like, oval and/or irregular, millimeter sized, carbonate relics (black arrows) give a mottled aspect, greasy luster, translucent; sparse wackestone fabric; matrix was completely replaced by cryptocrystalline quartz; particles are very fine-grained fragments of phosphatized echinoderms (orange arrows), ostracod bioclasts (blue arrow), agglutinated benthic (pink arrow) and planktonic foraminifera; high amount of quartz (yellow arrows) and clay grainclasts; **4-6**. Cementstone chert [05b] (FZ 2, deep shelf): from clear grayish-brown to light brown, sporadic whitish point-like and oval, millimeter sized, carbonate relics (black arrows), greasy luster, translucent; sparse wackestone to mudstone fabric, with fine grained silicified (red arrows) echinoderm bioclasts, ostracod fragments (blue arrow), bioclast molds (gray arrows), rounded fish fragments (purple arrow), sponge spicules (brown arrows), high amount of quartz grainclasts (yellow arrows), and agglutinated benthic (pink arrow) and planktonic foraminifera (green arrows); matrix was almost completely replaced by cryptocrystalline quartz; this microfacies is also characterized by burrows with silicified mudstone fabric (white arrows marking the limit), and some fractures filled by chalcedonic fibrous cement; macro photos - scale are 1 cm; micro photos - scales are 500 µm; XPL - cross-polarized light; photos by Al. Ciornei (2012).

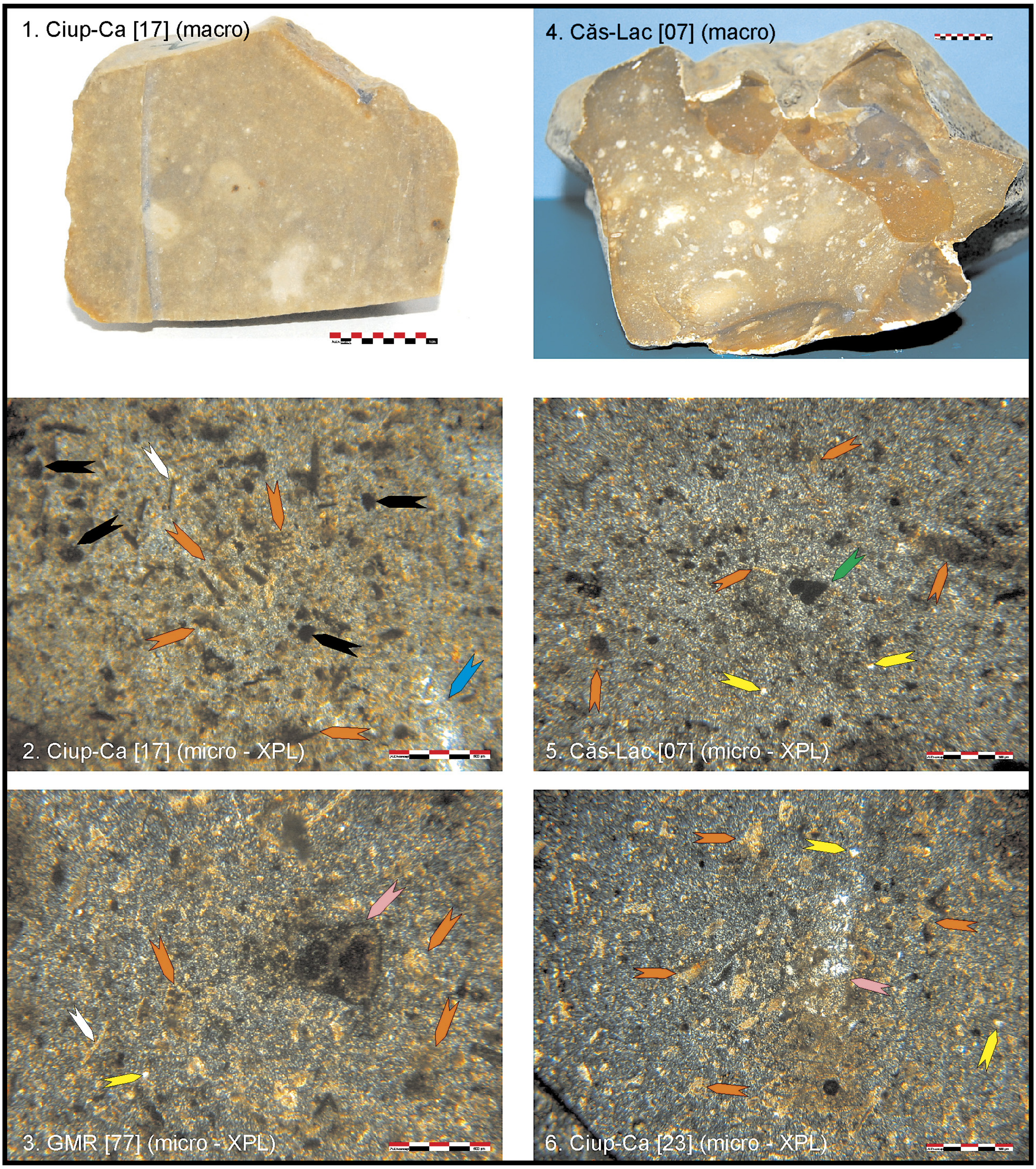

Plate 7. 1-3. Partially silicified bioclastic wackestone [06b] (FZ 2, deep shelf): from gray, grayish-brown, gray-greenish to brown, dull, semi-opaque; sparse wackestone fabric with fine-grained phosphatized bioclasts in a partially silicified matrix (< 4 μm), with algae and echinoderm fragments (orange arrows), silicified (gray arrows) and phosphatized sponge spicules (white arrows), some unidentified fossil molds (blue arrows), agglutinated benthic (pink arrows) and planktonic foraminifera, micropeloids (black arrows) and quartz grainclasts (yellow arrows); **4-6**. Phosphatized bioclastic wackestone chert [07b] (FZ 2, deep shelf): from yellowish-brown, grayish-light brown to light gray, greasy to dull luster, translucent, mottled (grayish-white point-like, oval and/or irregular, millimeter sized, carbonate relics); sparse wackestone fabric with fine-grained echinoderm and algae bioclasts (orange arrows), ostracods, phosphatized sponge spicules, rounded fish fragments (purple arrow), agglutinated benthic (pink arrow) and planktonic foraminifera (green arrow), sporadic quartz (yellow arrows) and clay grainclasts; bioclasts were imbedded in a matrix replaced by a siliceous cement (cryptocrystalline quartz); macro photos - scales are 1 cm; micro photos - scales are 500 μm; XPL - cross-polarized light; photos by Al. Ciornei (2012).

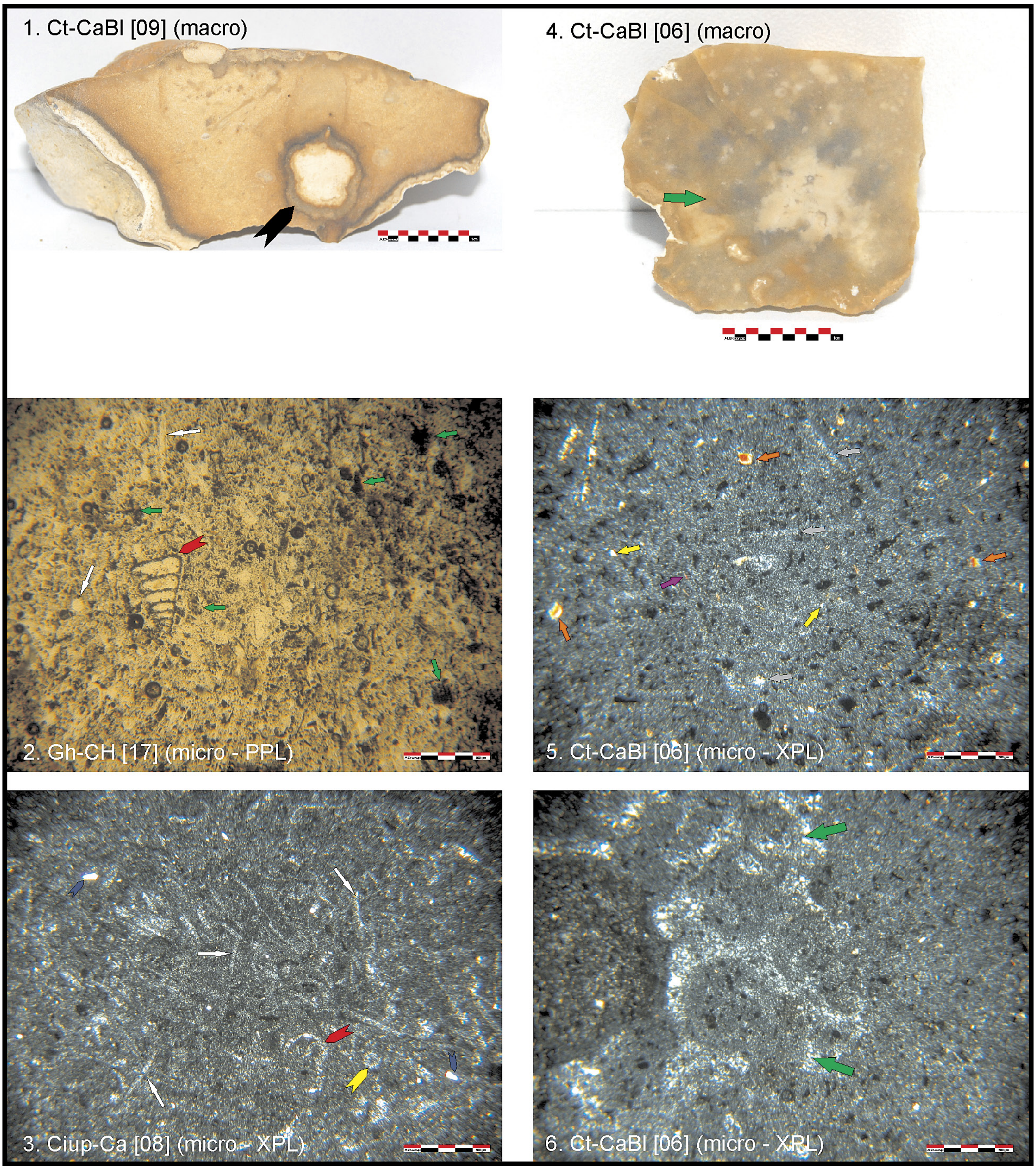

Plate 8. 1-3. Partially silicified spiculite-peloid wackestone [06a] (FZ 2, deep shelf): light colored, from cream to beige, dull, opaque, spotted because of small beige/cream-whitish carbonate relics (irregularly-oval); sparse wackestone fabric with very fragmented bioclasts (mixed benthic and planktonic elements) within a very burrowed micritic matrix (poorly silicified); sponge spicules (white arrows), together with benthic agglutinated foraminifera (red arrows), planktonic foraminifera, radiolarians (yellow arrows), small peloids (green arrows), and quartz grainclasts (blue arrows); this is characterized by either tubular perforations (channel like, seen as oval or circular areas, black arrow), siliceous cementstone fabric with sponge spicules (white arrows) and planktonic foraminifera, or burrows with very fragmented bioclasts; **4-6**. Sponge reef chert [09] (SMF 7-Bafflestone, FZ 5, platform-margin reefs): grayish-dark brown, greasy luster, translucent; silicified bafflestone composed of reef-building organism in life position (trapping sediment); the clear gray sponge body is filled up by botryoidal chalcedony and drusy megaquartz cements (green arrows), while the space around the sponge body is filled with a siliceous cement (cryptocrystalline quartz replacing the micrite matrix) and dispersed algae, echinoderms and sponge spicules bioclasts (gray arrows), rounded fragments of fish bones (orange arrows), quartz (yellow arrows) and clay minerals grainclasts (purple arrow); macro photos - scales are 1 cm; micro photos - scales are 500 µm; PPL - plane-polarized light; XPL - cross-polarized light; photos by Al. Ciornei (2013).

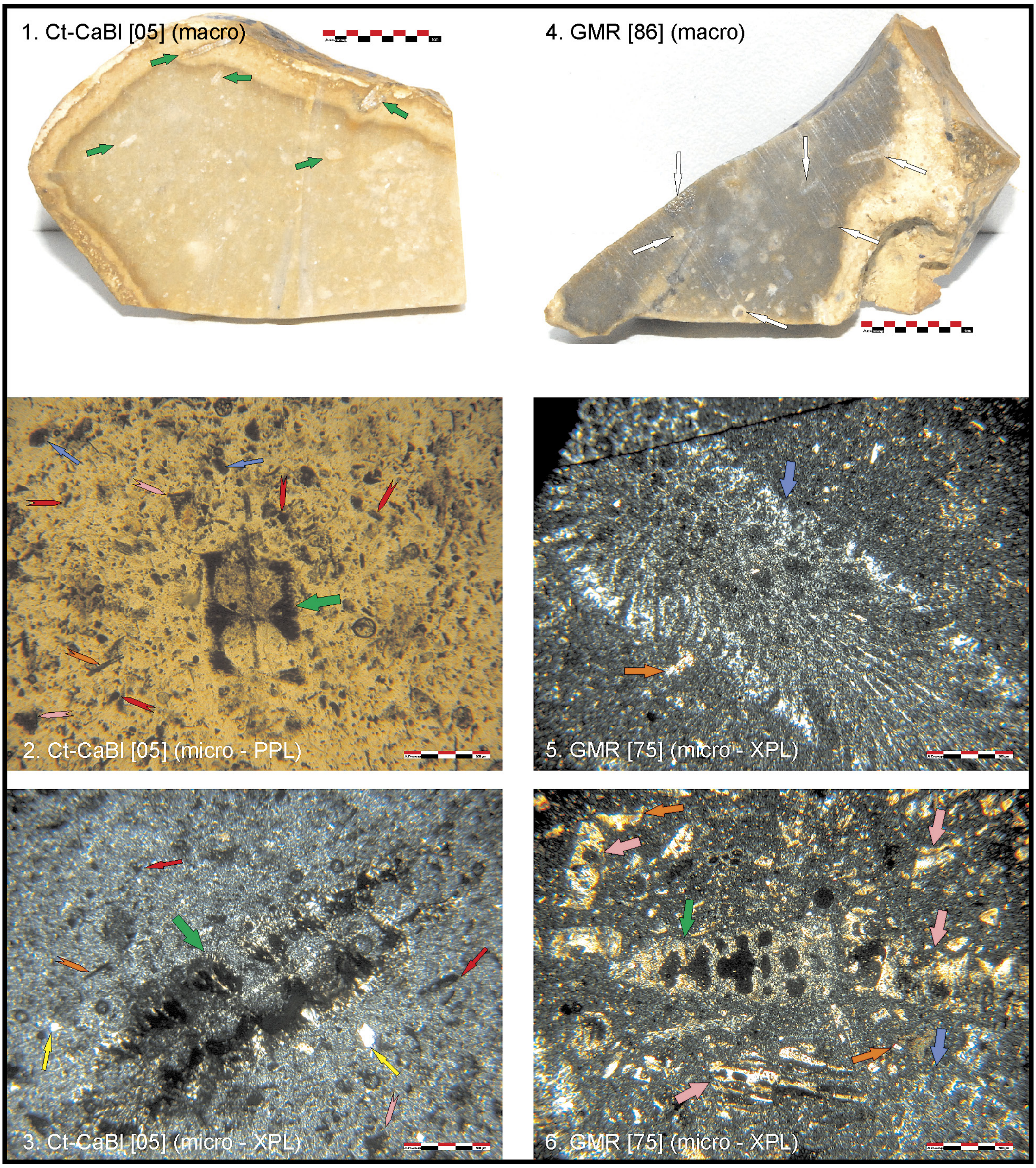

Plate 9. 1-3. Sporadic whole algae-bioclastic wackestone chert [07a] (FZ 2, deep shelf): grayish-dark brown, dull, semi-opaque; sparse wackestone fabric with; whole algae (green arrows, also visible with the naked eye), fine-grained bioclasts of algae (pink arrows), echinoderms (red arrows), calcareous sponge spicules (orange arrows), peloids (blue arrows), rounded fish bones, agglutinated benthic foraminifera, and quartz grainclasts (yellow arrows); micrite matrix replaced by a siliceous cement (cryptocrystalline quartz); **4-6**. Whole algae wackestone chert [08] (SMF 8, FZ 7, open shelf lagoon): from yellowish-brown (Ciup-Ca [10]) to gray, gray-greenish, and grayish-black (Ch-CH [12]), greasy luster to dull, translucent; sparse wackestone fabric with whole algae visible with the naked eye (white arrows), some of them are phosphatized and some are silicified (blue arrows); additional grains are fragmented algae (pink arrows), echinoderm bioclasts (orange arrows), and large benthic foraminifera (green arrows); matrix was replaced by siliceous cement (cryptocrystalline quartz); whole algae and the well preserved large benthic foraminifera indicate a low-energy, shallow-water marine environment (shelf lagoon with circulation); macro photos - scales are 1 cm; micro photos - scales are 500 µm; PPL - plane-polarized light; XPL - cross-polarized light; photos by Al. Ciornei (2012-2013).

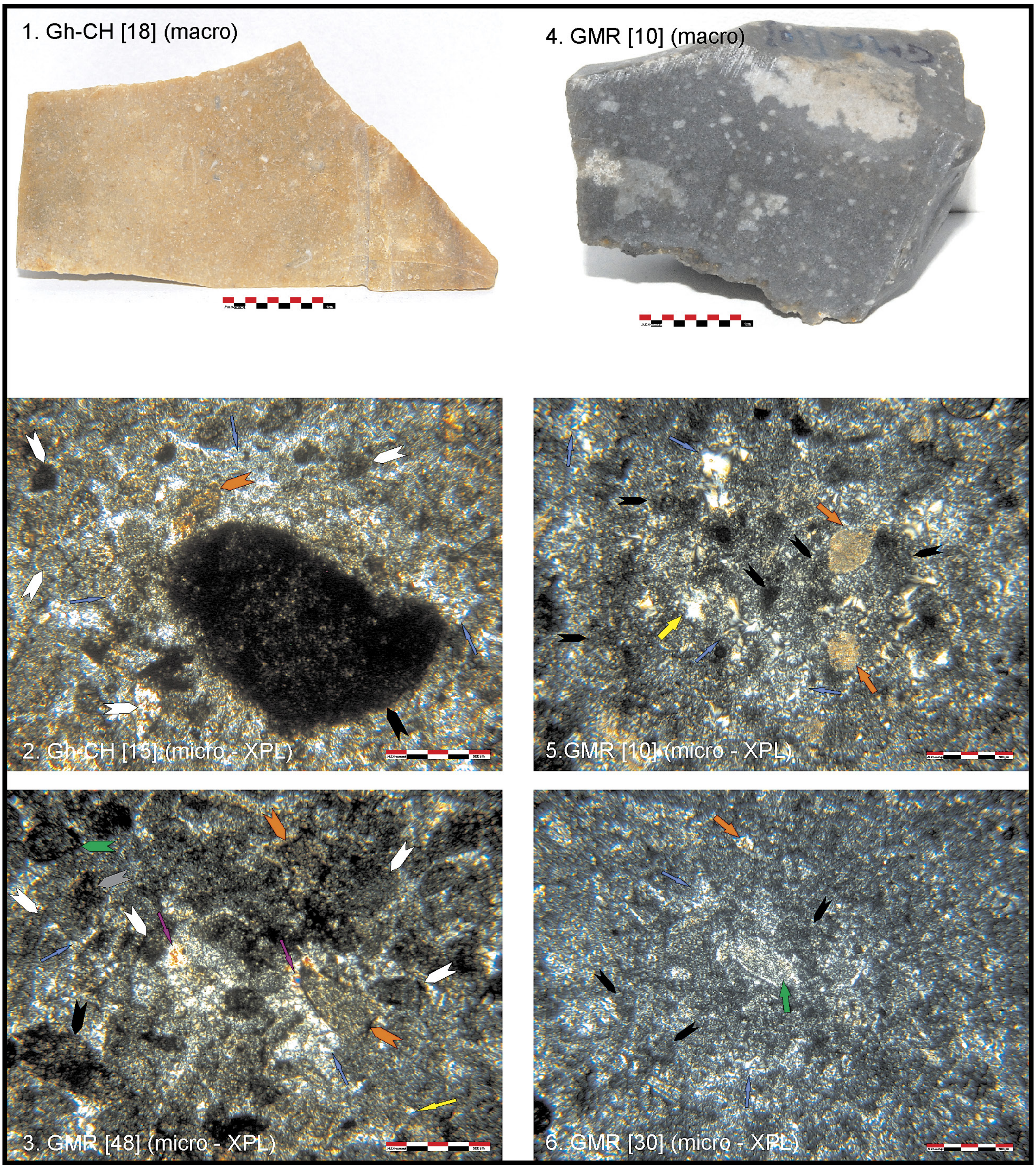

Plate 10. 1-3. Peloid-algae packstone chert [10a] (FZ 8, restricted platform interior): brown color, dull, translucent, with sporadic beige-whitish irregular, millimeter sized, carbonate relics; packstone fabric with equal sized peloids (white arrows), algae and echinoderm bioclasts (orange arrows), sporadic rounded fish fragments (purple arrows), quartz grainclasts (yellow arrows), and benthic foraminifera (green arrows); also intraclasts composed either of micrite, bioclasts and quartz grainclasts (gray arrows), or micrite, quartz and clay grainclasts (black arrows); linear, tangential, free and concave-convex contacts between grains and some remnant micrite matrix; intergranular botryoidal chalcedony cement (blue arrows); **4-6**. Peloid-echinoderm packstone chert [10b] (FZ 8, restricted platform interior): from gray to rosy, dull, translucent; packstone fabric with peloids (black arrows), fine-grained phosphatized (orange arrows) or silicified (green arrows) echinoderm bioclasts, quartz grainclasts (yellow arrows), intraclasts, and benthic foraminifera; linear, tangential, free and concave-convex contacts between grains and some remnant micrite matrix; intergranular botryoidal chalcedony cement (blue arrows); the echinoderm plates have overgrowth cement (syntaxial cement) partially replaced by megaquartz drusy cement; partially silicified peloids in samples GMR [10], GMR [22], GMR [102] give a granulated macroscopic aspect; macro photos - scales are 1 cm; micro photos - scales are 500 µm; XPL - cross-polarized light; photos by Al. Ciornei (2012-2013).

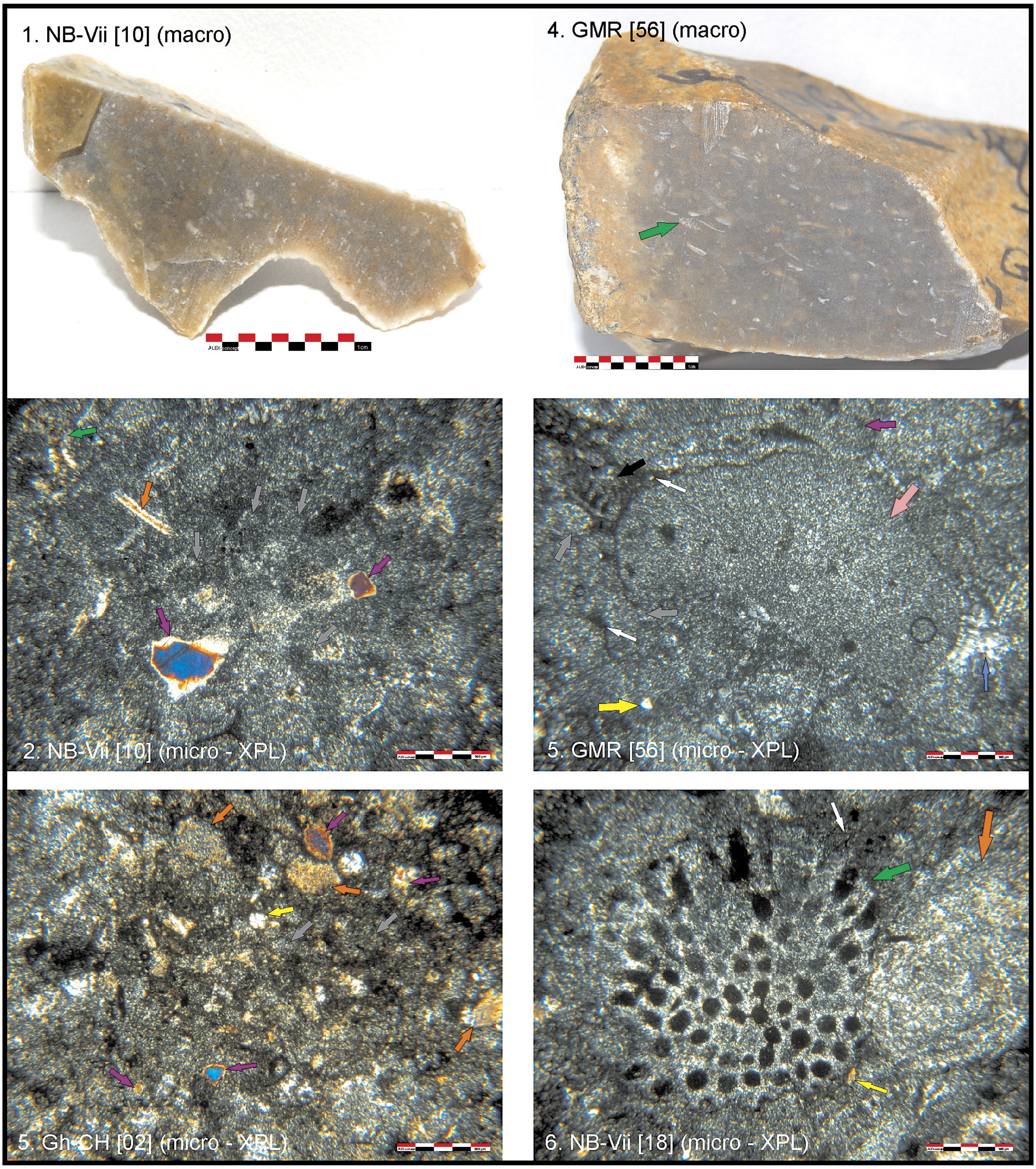

Plate 11. 1-3. Peloid-echinoderm-algae packstone chert [11a] (FZ 8, restricted platform interior): from grayish-black (Gh-CH [2]), grayish-rosy (Gh-CH [3], GMR [45]), to brown and dark brown (Gh-CH [4], GMR [50], NB-Vii [10]), dull, translucent; packstone fabric with silicified peloids (gray arrows), fragmented echinoderm plates (orange arrows), algae bioclasts (green arrow), rounded fragments of fish bones (purple arrows), sponge spicules (yellow arrow), benthic biseriate and Miliolid foraminifera; some of the peloids preserved their original mineralogy, while others passed through a mold stage; the micrite matrix was replaced by cryptocrystalline quartz, and pore space between particles was filled by botryoidal chalcedonic cement; **4-6**. Bioclastic-peloidal packstone chert [11b] (FZ 8, restricted platform interior): reddish brown and grayish black, greasy luster, very translucent; packstone fabric with predominant rounded algae fragments (green arrow), echinoderm plates (orange arrow), peloids (gray arrows), rounded lithoclasts (pink arrows), benthic foraminifera (black arrow), and quartz grainclasts (yellow arrows); contacts between grains are linear, tangential, and concave-convex; space between grains is filled by silicified matrix (white arrows) and botryoidal chalcedony cement (blue arrow); macro photos - scale are 1 cm; micro photos - scales are 500 µm; XPL - cross-polarized light; photos by Al. Ciornei (2012-2013).

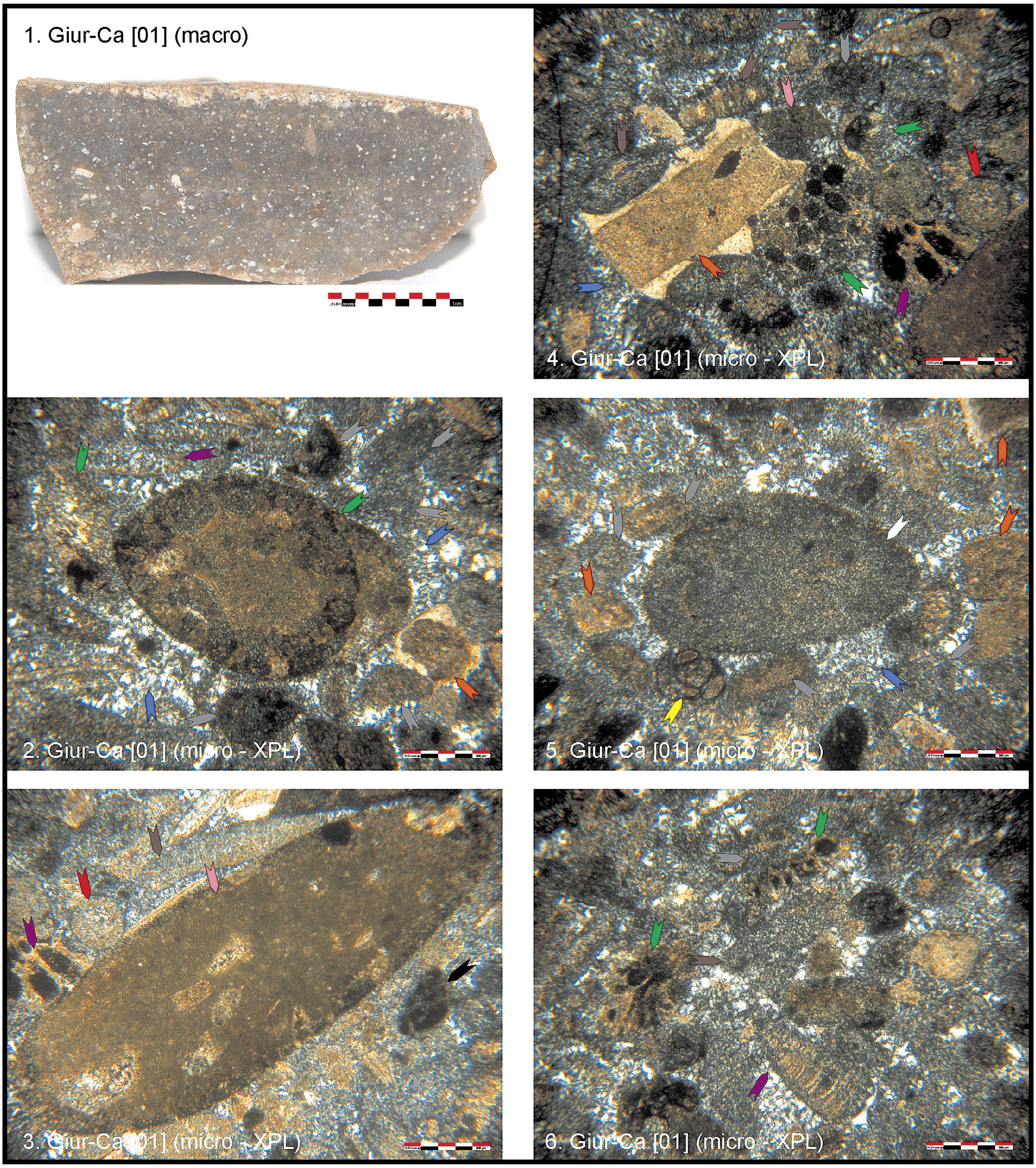

Plate 12. Peloid-cortoid grainstone chert [12a] (FZ 8, restricted platform interior): dark brown, dull, translucent; grainstone fabric with peloids (gray arrows), silicified (white arrow) and phosphatized (pink arrow) lithoclast, rounded fragments of algae (green arrows), echinoderm plates with overgrowth syntaxial cement (orange arrows), benthic biseriate (purple arrows) and Miliolid (yellow arrow) foraminifera, ooids (red arrows, micritized foraminifera (black arrows), cortoids (brown arrows); cortoids indicate a shallow-water marine environment; roundness of bioclasts and lithoclasts, relative high amounts of cortoids refer to constant agitated waters, at or above wave base line (Flügel, 2010: 121); elongated-oval grains are orientated along bedding plane; linear, tangential, and concave-convex contacts between grains and reoriented particles imply strong sediment compaction; pore space is filled by botryoidal chalcedony cement (blue arrows); macro photo - scale is 1 cm; micro photos - scales are 500 µm; XPL - cross-polarized light; photos by Al. Ciornei (2013).

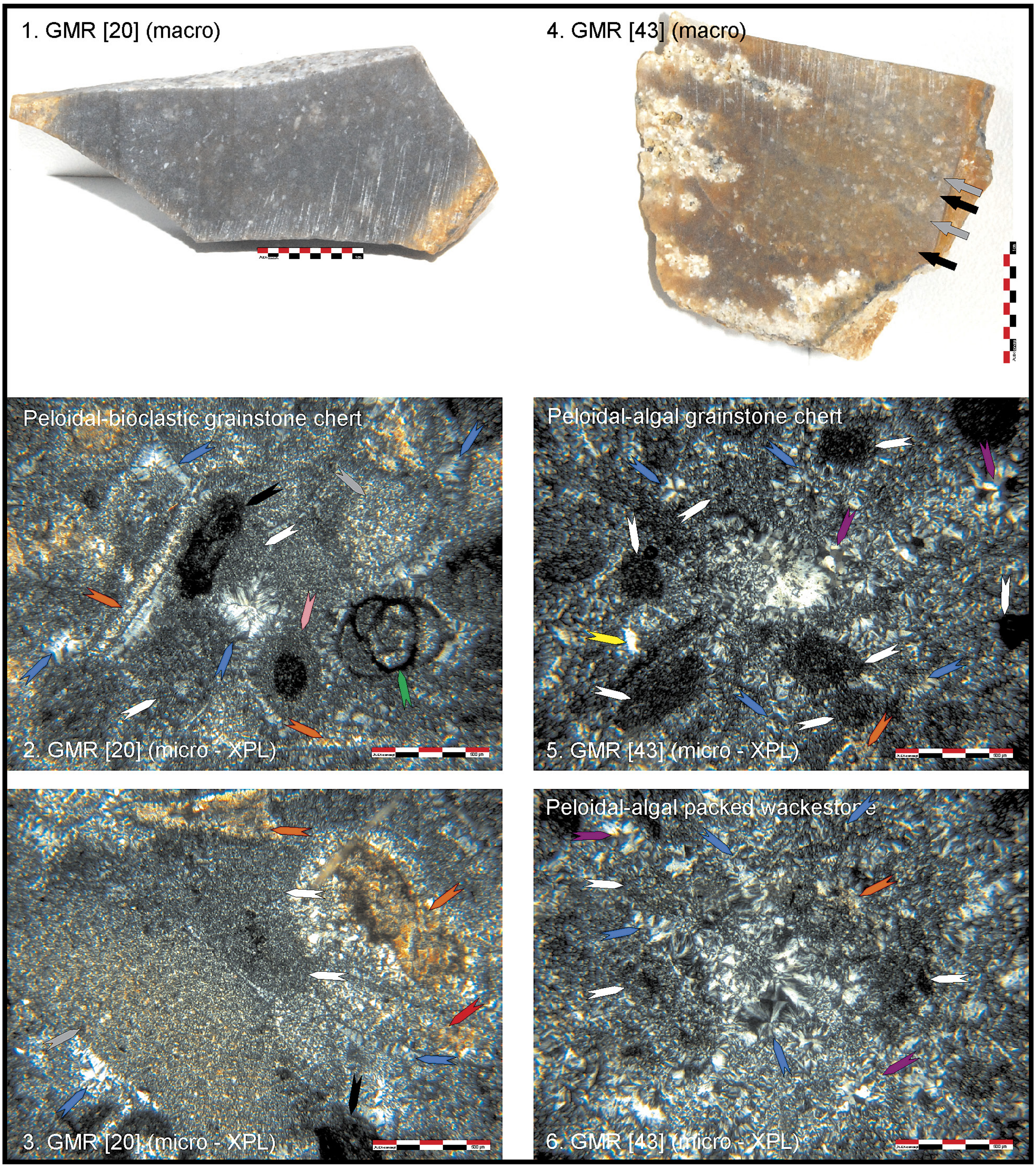

Plate 13. 1-3. Peloidal-bioclastic grainstone chert [12b] (FZ 8, restricted platform interior): bluish-gray color, greasy luster, translucent; grainstone fabric with silicified (white arrows) and micrite (black arrows) peloids, intraclasts (gray arrows; cryptocrystalline quartz and quartz grainclasts), algae and echinoderm bioclasts (orange arrows), Miliolid foraminifera (green arrow), and ooids (pink arrow); linear, tangential, and concave-convex contacts between grains, pore space filled with botryoidal chalcedony cement (blue arrows) and drusy megaquartz cement; **4-6**. Peloidal-algal grainstone chert [12c] (FZ 8, restricted platform interior): rusty brownish, greasy luster, very translucent; alternation of clear gray (gray arrows; packed wackestone fabric) and brown laminae (black arrows; grainstone fabric); grainstone fabric (5) with silicified peloids (white arrows), bioclasts (orange arrow), and quartz grainclasts (yellow arrow); linear and tangential contacts between grains with intergranular botryoidal chalcedonic (blue arrows) and drusy megaquartz cement (purple arrows); packed wackestone (6) with peloids partially silicified (white arrows) and bioclasts (orange arrow); intergranular botryoidal chalcedony (blue arrows) and drusy megaquartz cement (purple arrows); macro photos - scale are 1 cm; micro photos - scales are 500 µm; XPL - cross-polarized light; photos by Al. Ciornei (2012).

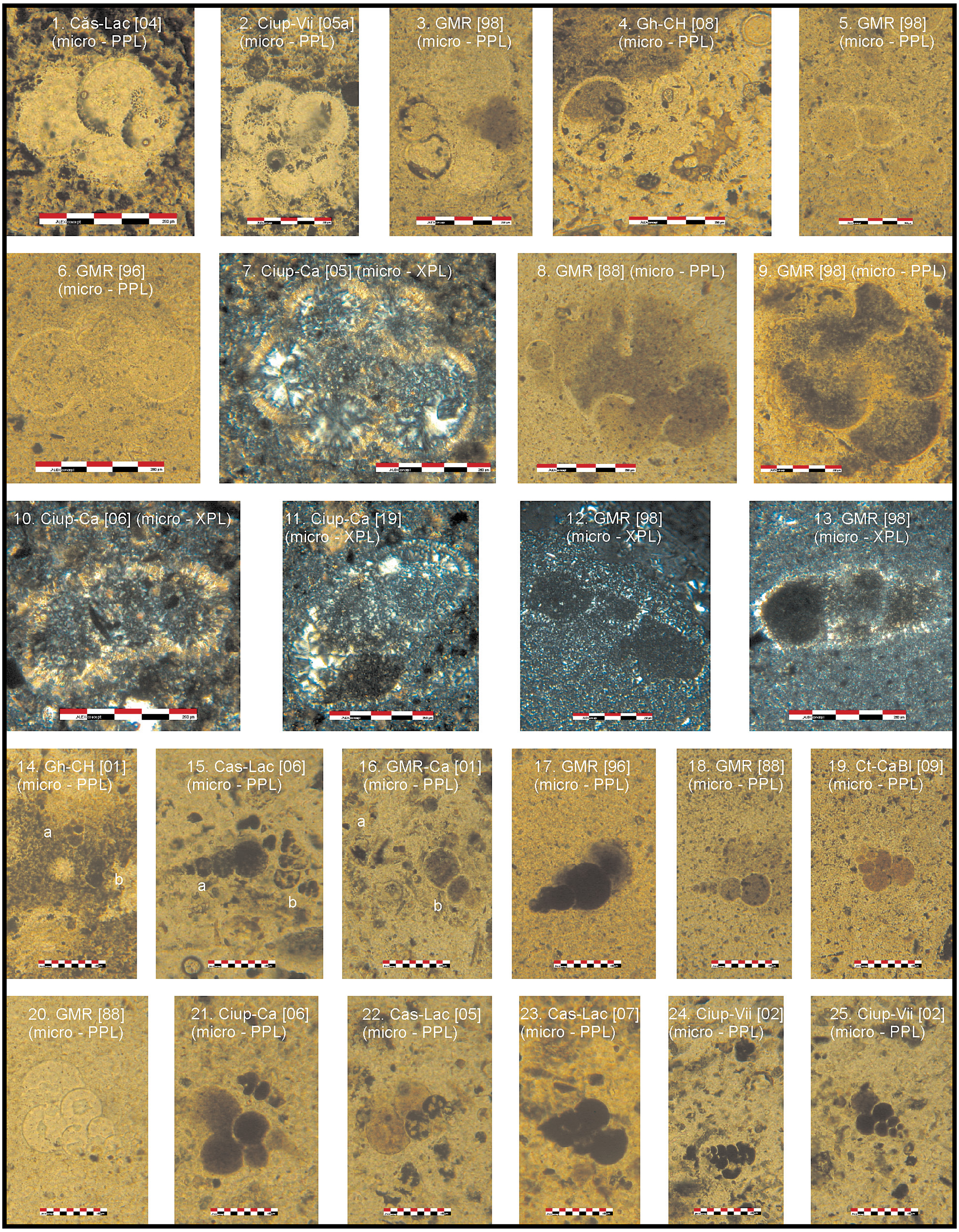

Plate 14. Lower Danube Valley cherts: transversal (**1-3**) and axial (**4-6**) sections through foraminifera from *Hedbergellidae* family (superfamily Globigerinoidea; family range from Lower Cretaceous to Paleocene, BouDagher-Fadel 2013: 65-66); transversal (**7-9**) and axial (**10-13**) sections through foraminifera from *Globotruncana* Cushman genus (*Globotruncanidae* family, superfamily Globigerinoidea; genus range from Late Coniacian to Maastrichtian, BouDagher-Fadel, 2013: 67-68); transversal (**14b**, **16a**), longitudinal (**15a**, **16b-18**) and axial (**14a**, **19-25**) sections through foraminifera from *Heterohelix* Ehrenberg genus (family Heterohelicidae, superfamily Heterohelicoidea; genus range from Late Albian to Maastrichtian, BouDagher-Fadel, 2013: 70-71); micro photos **1-13** - scales are 250 μm; micro photos **14-25** - scales are 100 μm; PPL - plane-polarized light; XPL - cross-polarized light; photos by Al. Ciornei (2012-2013).

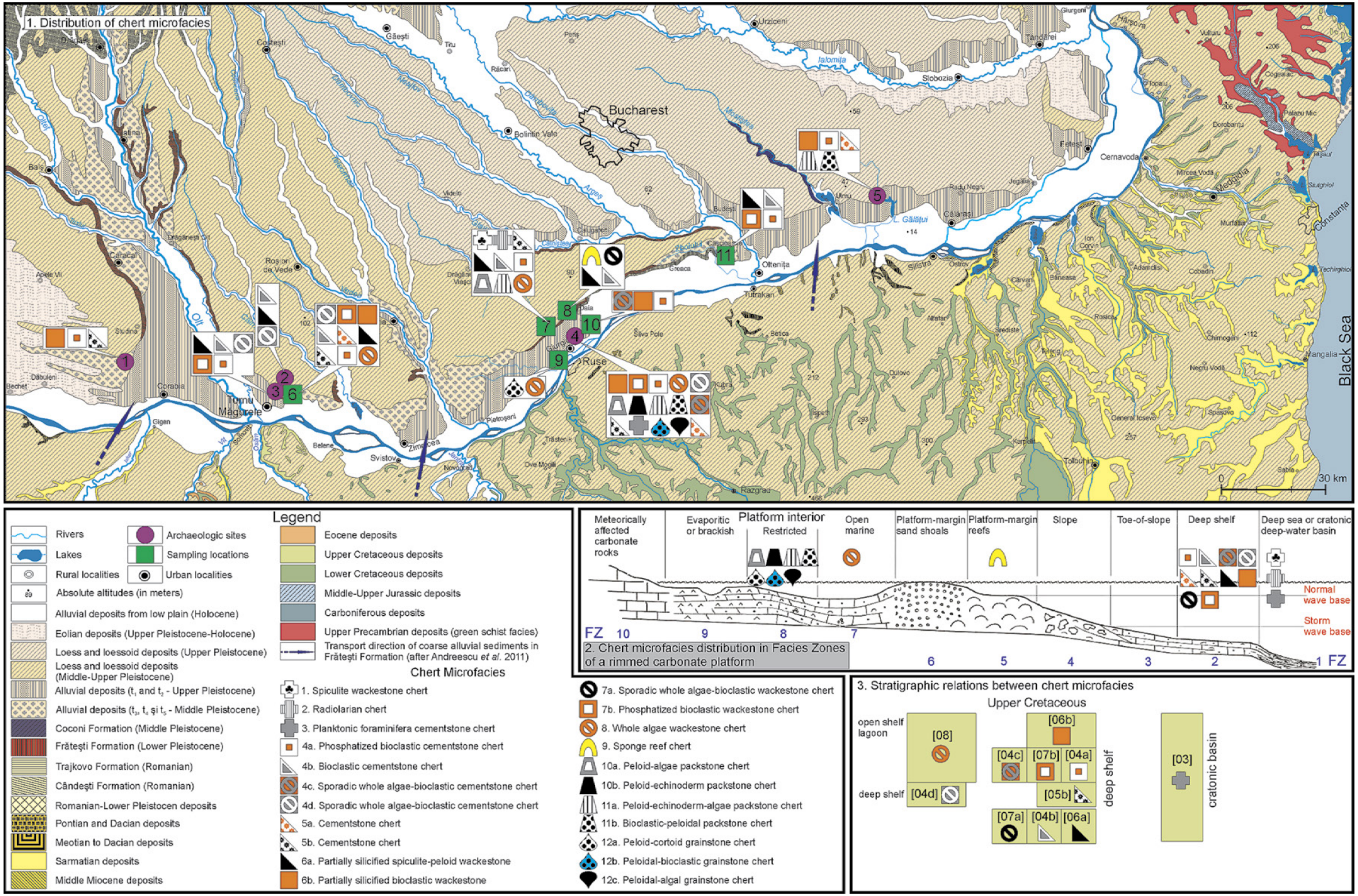

Plate 15. Lower Danube Valley chert microfacies: **1**. Distribution of chert microfacies in archaeological sites (1. Vădastra-Măgura Fetelor, 2. Ciuperceni-La Tir, 3. Ciuperceni-La Vii, 4. Giurgiu-Malu Roşu, 5. Nicolae Bălcescu-La Vii) and sampling locations (6. Ciuperceni-Quarry, 7. Ghizdaru-Haltă Quarry, 8. Cetatea-Bălănoaia Quarry, 9. Giurgiu-South-West Quarry, 10. Giurgiu-Malu Roşu Quarry, 11. Căscioarele-East side of the Lake); digital map redrawn after Geological Map of Romania 1: 1000000 (1978), with modification regarding Pliocene and Pleistocene Series names and chronostartrigraphy (after Andreescu *et al.* 2011); **2**. Chert microfacies distribution in Standard Facies Zones of a rimmed carbonate platform (after Flügel, 2010: 662, with modifications); **3**. Stratigraphic relations between chert microfacies.

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