MICROFACIES ANALYSIS OF CHERTS FROM PEȘTERA - DEALU GURAN SITE (LOWER PALAEOLITHIC), CONSTANȚA COUNTY, ROMANIA*

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Keywords: *chert, microfacies analysis, chert microfacies, chert sources, supply strategies, raw-material preference, Peștera Valley, Peştera-Dealu Guran, Lower Palaeolithic.*

Cuvinte cheie: *silicolit, analiza de microfacies, microfaciesuri silicolitice, surse de silicolite, strategii de aprovizionare, materie primă preferată Valea Peștera, Peştera-Dealu Guran, Paleolitic Inferior.*

Abstract: *This study focuses on petrographic analysis of chert samples from Peştera-Dealu Guran site (Lower Palaeolithic) and from Peştera-Dealu Peşterica (sampling location), both located on Peștera Valley (Peştera village, Constanța County, Romania). Macroscopic examination of geological and archaeological hand specimens established visual characteristics of cherts and allowed the primary separation of samples and selection for thin sections. Microfacies analysis was carried on 19 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. This microfacies analysis delivered the means to characterize and classify cherts (chert microfacies), while sedimentary interpretations of microfacies strengthened and supported them as valid chert varieties reflecting local sedimentation conditions in a regional geological setting (a rimmed carbonate platform). This analysis also established the use of these chert varieties as raw-materials for tool productions in the Lower Palaeolithic site of Peştera-Dealu Guran.*

Rezumat: *Acest studiu se concentrează pe analiza petrogarfică (analiza de*

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microfacies) a probelor de silicolit provenite din situl Peştera-Dealu Guran (Paleolitic Inferior) şi o locaţie de eşantionare apropiată (Peştera-Dealu Peşterica), ambele localizate pe Valea Peștera (sat. Peştera, com. Peştera, judeţul Constanţa, România). Analiza macroscopică a eşantioanelor geologice şi arheologice a permis evaluarea caracteristicilor vizuale şi separarea probelor pentru prepararea a 19 secţiuni subţiri. Analiza de microfacies presupune estimarea categoriilor de particule, recunoaşterea grupurilor sistematice de fosile, a matricei şi tipurilor de ciment. Pentru fiecare secţiune subţire, aceşti constituenţi primari au fost evaluaţi folosindu-se comparatoare de estimare vizuală. Această analiză a permis caracterizarea şi clasificarea silicolitele din cadrul studiului (microfaciesuri silicolitice), în timp ce interpretarea sedimentologică a întărit şi validat microfaciesurile ca varietăţi de silicolite ce reflectă condiţii locale de sedimentare într-un cadru geologic regional (platformă carbonatică barată). Din punct de vedere arheologic rezultatele nu sunt spectaculoase: au fost identificate tipurile de materii prime utilizate pentru unelte de către locuitorii din Paleoliticul Inferior de la Dealu Guran, dar şi sursa probabilă de aprovizionare. Această sursă are caracter local, distanţele de transport între sursă şi sit fiind minime. Strategia de aprovizionare relevată de acest studiu este una relativ simplă, care presupunea exploatarea tipurilor şi cantităţilor de silicolite disponibile în sursă: un depozit de brecie polimictică ce conţine numeroşi galeţi de silicolit nodular cu foraminifere planctonice aparţinând Cretacicului Superior (Campinian-Maastrichtian), iar subordonat plachete sau dale de silicolit peloidal aparţinând Cretacicului Superior (Cenomanian).

1. Introduction

Throughout its history, archaeological research of Palaeolithic sites from Dobrogea area (Romania) has been orientated towards typology and chronology, while raw-material characterization and provenance has been a rather peripheral and unsystematic preoccupation. A notable exception to this practice is the middle ’50s field surveys for Palaeolithic sites, when C. S. Nicolăescu-Plopşor attached as a secondary aim the identification of flint outcrops in Dobrogea[1]. Flint was considered as the main or only raw-material used in Palaeolithic sites from Dobrogea, a region rich in outcropping deposits of limestones with flints (this compared with the Romanian Plain, Oltenia and Muntenia regions, where such deposits don’t outcrop at all). Also, the majority of Palaeolithic sites were found near or above the flint supply sources[2]. Thus, there was no need to tightly differentiate varieties, and, as consequence, petrographic analyses of raw-materials are sporadic or missing entirely.

Păunescu has systemized geological information about “natural deposits of flints”, outlining “micro-zones” of possible supply sources in Northern, Central and Southern Dobrogea[3]. In Northern Dobrogea, deposits that outcrop contain “siliceous accidents such as spongolites, spongolitic *cherts*, gray, whitish, and black (lidite) cherts, *chaille*, flint and silexites, but also quartz sandstones, quartzitic sandstones and gray quartzite”[4]. In Central Dobrogea, *cherts* and *chaille*

[1] NICOLĂESCU-PLOPŞOR *et al.* 1959, p. 15-17.
[2] PĂUNESCU 1996-1998, p. 83.
[3] PĂUNESCU 1996-1998, p. 83-91; 1999, p. 38-43.
[4] PĂUNESCU 1996-1998, p. 83.

are found in the Middle Callovian deposits, while flints are contained in Upper Oxfordian and Oxfordian-Lower Kimmeridgian deposits[5]. In Southern Dobrogea, Campanian to Maastichtian flint deposits outcrop in two micro-zones, between Carasu Valley-Nazarcea-Valul lui Traian-Ovidiu and between Satu Nou-Medgidia-Cuza Vodă-Ducozol, but also South of Carasu Valley as patches (Peștera Valley, Techechioi Valley, and Enisemlia Valley)[6]. Păunescu's overview is only based on geological literature (uncritically integrated) and has a regional value due to lack of petrographic characterization of siliceous materials.

A recent study overviews geological siliceous lithic materials from Southern Romania[7] 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); 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. Crandell's description of siliceous materials ignores the established flint types from Bulgaria and their distribution in this territory[8], but also Păunescu's overview of flint types in Dobrogea[9].

Regionally defined flint/chert types include materials from the same geological period or age (in some cases from different periods), having similar or variable macroscopic aspects (colors, shades and play of colors, structure and texture) and heterogeneous microscopic characteristics. The possibility that regionally defined flint/chert types might include different varieties, that should be acknowledged as such, is supported by conflicting results of thin sections and geochemical analysis of archaeological and geological samples from Bulgaria[10]: microscopic investigation has proven itself as an inefficient tool due to a mineralogically-oriented and generalizing criteria that resulted in insufficiently described and understood petrographic characteristics, while geochemical analyses proved a very high chemical variability within each flint/chert type that impaired clear provenance of archaeological samples. The recent study of Lower Danube Valley cherts recognized a greater petrographic variability within each regionally defined chert types, such as the Moesian flint or the Ludogorie flint[11]. Some of the chemical variability might be in relation to this petrographic variability explained through sedimentological and diagenetic characteristics that support the dismantling of regionally defined chert types in two or more independent varieties. Thus, it becomes clearer that geochemical analysis should be used not as an alternative, but as a complementary investigation technique to a

[5] PĂUNESCU 1996-1998, p. 85.
[6] PĂUNESCU 1996-1998, p. 86.
[7] CRANDELL 2013.
[8] GUROVA & NAHCEV 2008.
[9] PĂUNESCU 1996-1998.
[10] BONSALL *et al.* 2010, ANDREEVA *et al.* 2014.
[11] CIORNEI 2013a; 2013b; CIORNEI *et al.* in press.

more detailed petrographic analysis.

This study presents a small-scale petrographic analysis focused on samples from Peştera-Dealu Guran (Peștera Valley, Southern Dobrogea, Romania), trying to characterize chert* varieties used as raw-materials and to establish their provenance, putting forward microfacies analysis as an investigation methodology able to differentiate varieties based on sedimentological and diagenetic features observed in thin sections.

2. Archaeological and geological context

This study is focused on the raw-material used for tool making in the Lower Palaeolithic site of Peştera-Dealu Guran (a collapsed rockshelter), located near the North-West side of Peştera village and on the left side of the Peștera Valley (Peștera commune, Constanța County, Southern Dobrogea, Romania), at about 40 km West of Constanța city (see Pl. 1). This site was discovered as a result of the "Lower Danube Survey for Paleolithic Sites (LoDanS)"[12] project, coordinated by Radu Iovita and Adrian Doboş, undertaken in Southern Dobrogea in the period 2010-2012[13].

Peştera-Dealu Guran is the oldest Lower Palaeolithic site in Romania that has a secure and dated archaeological context, excavated during 2011-2012[14]. The site contains three hominid occupational layers dated (using OSL, IRSL, and post-IR IRSL luminescence techniques) to 320 ± 21 ka, 388 ± 36 ka and 392 ± 23 ka (corresponding to MIS 11, Middle Pleistocene)[15]. The lithic assemblage from 2011 excavation contains 561 artefacts with whole and broken flakes and cores[16], but no formal tools, denoting "complete reduction sequences"[17] consider the lithic industry of Dealu Gura as beeing similar with those from Olduvai (MNK Chert Factory), Israel (Mt Pua) and Anatolia (Kaletepe Deresi 3).

The surface of Southern Dobrogea is covered by a thick blanket of loess and loess-like deposits. In its basement is found the structural-tectonic unit named Dobrogean Sector of the Moesian Platform. This sustains a Paleozoic-Neozoic sedimentary cover of about 3500 m[18], outcropping only the Lower Cretaceous to Pliocene deposits (see Pl. 1, Table 1).

In this area, cherts are found both in primary and secondary positions: as slabs and nodules in a breccia at the base of a mottled orange-green sandy limestone around the Peştera village (see Table 1); as nodules in chalks of Murfatlar Formation (see Table 1); as lenses at different stratigraphical levels in a

* In this study, *chert* is used with the general geological meaning that concerns all siliceous rocks of chemical, biochemical or biogenic origin.

[12] IOVITA *et al.* 2013.

[13] The project and its results are presented extensively in IOVITA *et al.* (2013).

[14] ZIRRA *et al.* 2012, p. 98; ZIRRA *et al.* 2013, p. 101; IOVITA *et al.* 2012; 2013). For a detailed and inclusive geological and archaeological context of the site, the reader is referred to IOVITA *et al.* (2012).

[15] IOVITA *et al.* 2012, p. 977-979.

[16] IOVITA *et al.* 2012, p. 979-981.

[17] IOVITA *et al.* (2012, p. 985).

[18] ION *et al.* 2000-2001, p. 74.

bedded calcareous glauconitic quartz sandstone[19]. Murfatlar Formation (Santonian-lowermost Upper Campanian) corresponds to what[20] described as Santonian, Campanian and Maastrichtian deposits. Murfatlar Foramtion is exposed East of Cuza Vodă-Peștera-Lespezi alignment, along the Carasu valley and Siutghiol shore[21], but also on the left side of Peştera Valley[22]. Unit 1 from[23] matches with Peștera Formation (Early Cenomanian), which outcrops along both sides of Peștera Valley between villages Peștera and Cochirleni[24].

3. Materials and methods

This raw-material study is part of the archaeological investigations at Peştera-Dealu Guran site (acronym P-DG) and was accomplished in two phases. The first phase was carried during 2011 archaeological excavations and included a field survey at Peştera-Dealu Peşterica (acronym P-DP), located to the E-NE, on the right side of Peştera Valley. Here, samples were collected from: polymictic breccia[25] containing chert slabs and nodules (samples P-DP [01]-[08]; Pl. 2 and 3) found at the base of unit 3; chert lenses in the bedded calcareous glauconitic quartz sandstone (unit 1), just above the caves (sample P-DP [09]; Pl. 2 and 3). The second phase of the study was completed during the year 2013 and comprised the visual evaluation of raw-material variability and sampling of the lithic assemblage from Peştera-Dealu Guran site, the macroscopic examination of geological and archaeological hand samples and the microfacies analysis of thin sections.

Macroscopic examination of geological and archaeological hand specimens 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 reminiscences, naked eye visible fossils). This resulted in separation of a few varieties based on visual variability. To cover this variability, 19 thin sections were prepared from 16 samples (9 from the archaeological site, and 7 from the geological deposits).

Microscopic analysis was carried 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 photomicrographic camera (Wide Fild 10× and digital zoom of 3×), using mostly the 4× magnification (for general views of thin sections), and 10× magnification for details (such as microfauna). In the microscopic characterization of Peştera Valley cherts, the author applied the microfacies analysis concepts of carbonate rocks[26]. In this regard, special attention was given to: grain categories, amount,

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[19] Unit 1 of IOVITA *et al.* 2012, p. 976.
[20] CHIRIAC 1968, p. 32-33.
[21] AVRAM *et al.* 1993, p. 299.
[22] CHIRIAC 1968, p. 32-33.
[23] IOVITA *et al.* (2012, p. 976).
[24] CHIRIAC 1968, p. 29-30; AVRAM *et al.* 1993, p. 295.
[25] Unit 2 in IOVITA *et al.* 2012, p. 976.
[26] WILSON 1975; FLÜGEL 2010.

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.

Recorded mineralogy of each grain type, cement and matrix represents the basis for estimated mineralogical composition for 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. Silicification intensity was determined by summing up the percentage of siliceous particles and the percentage of siliceous cement in each thin section.

4. Characterization and classification of chert microfacies

Using the criteria described in the previous section 6 chert microfacies were differentiated**. In following lines, a short description of these will be given, while main characteristics are to be found in Tables 2-5, Charts 1-4, and in texts of Plates 4-8.

Grain-support and depositional fabric split chert microfacies in two groups (Table 3): grain-supported fabrics (grainstone and packstone depositional fabrics, including microfacies [01] and [02]) and matrix-supported fabrics (wackestone and mudstone depositional fabrics, including microfacies [03] to [05b]). Predominant grain types separate samples analyzed in three categories (Chart 1): peloidal cherts composed of silicified limemud peloids (microfacies [01] and [02], Pl. 4), detrital-rich cherts composed of terrigenous quartz (microfacies [03], Pl. 5), and bioclastic cherts composed of bioclasts (microfacies [04], [05a] and [05b]). Inside the bicolastic microfacies (Chart 2), type of microfauna differentiates the radiolarian chert (microfacies [04], Pl. 5) from foraminifera chert (microfacies [05a] and [05b], Pl. 6-8). Two foraminifera microfacies were discriminated through depositional fabric and amount of foraminifera contained.

Depositional fabric and fossil association indicate depositional settings that range from restricted platform interior to cratonic basin (see Table 4): the peloidal grainstone and packstone cherts represent inner platform peloidal limestones, the first of which contains quartzarenite laminae; the detrital-rich chert reflects a deep shelf setting phosphetized chalk with thin laminar accumulations of quartzwacke and quartzarenite (in a toe-of-slope setting); the radiolarian chert represents sedimentation in a deep water setting (cratonic basin); the nodular foraminifera chert corresponds to sedimentation in deep water depositional setting, with fluctuating conditions that formed alternating laminae and thins beds of planktonic foraminifera wackestone and mudstone (that is, both microfacies represent vertical variations in a mudstone-wackestone sedimentation pattern; see Pl. 8).

** The chert microfacies encompass all petrographic characteristics determined in one or more thin sections.

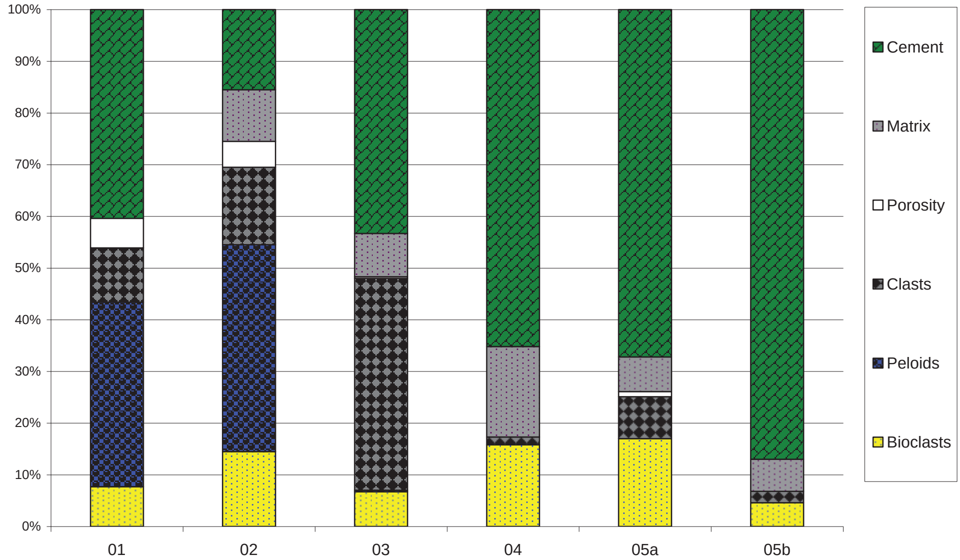

Chart 1 - Primary constituents of chert microfacies from Peştera Valley.

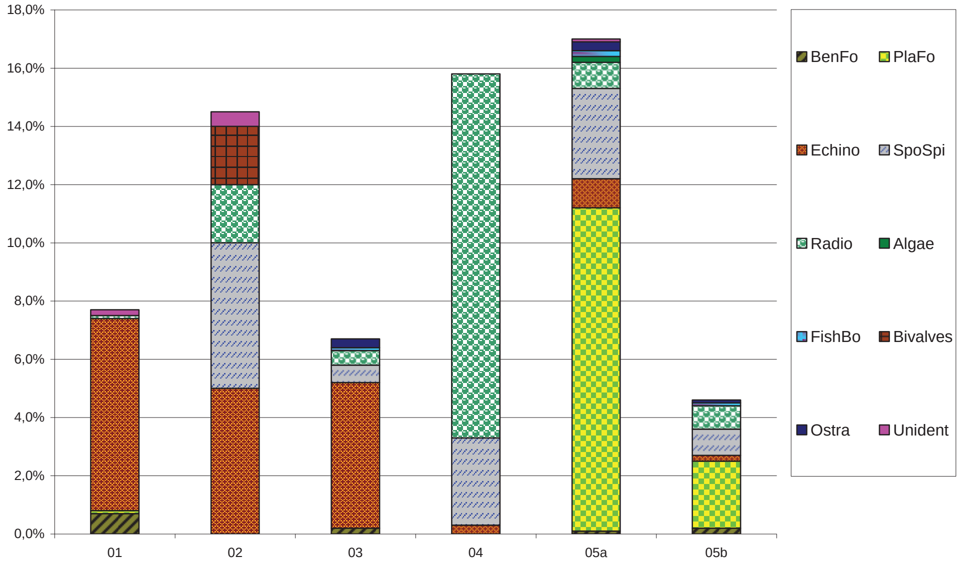

Chart 2 - Petrographic fossil distribution in chert microfacies from Peştera Valley; Legend: Unident – Unidentified fossils; Ostra – Ostracodes; Bivalves – fragments of bivalve shells; FishBo – fragments of fish bones; Algae – fragments and fragmented parts of calcareous algae; Radio – Radiolarians; SpoSpi – Sponge spicules; Echino – fragments of echinoderms; PlaFo – planktonic foraminifera; BenFo – benthic foraminifera.

All samples analyzed have a diagenetic fabric overlaying the sedimentary arrangement, with selective dissolution and cementation, silicification and recrystallization as the main diagenetic processes that differentiate these microfacies (Table 5, Chart 3).

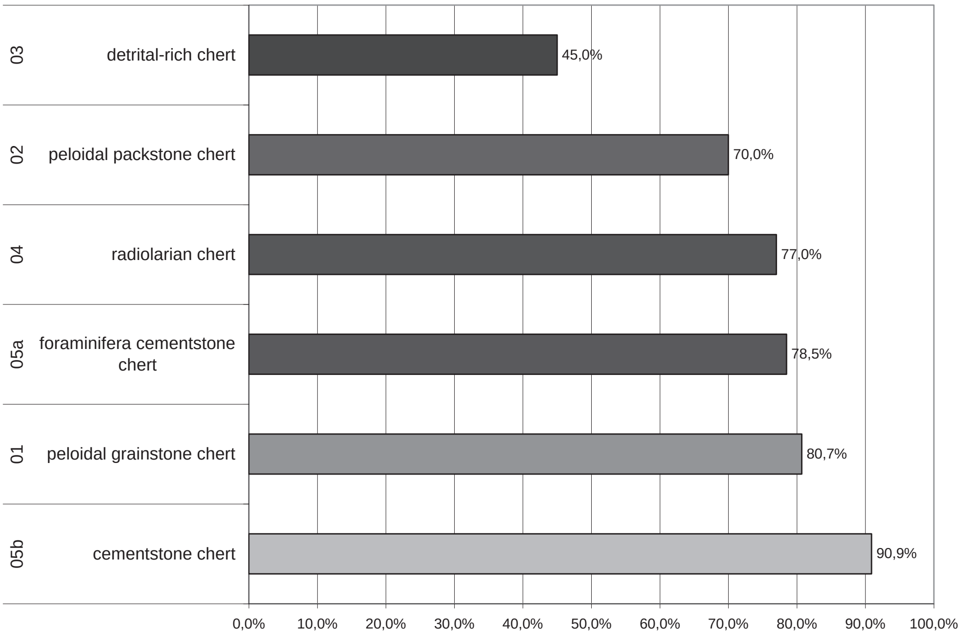

Chart 3 - Silicification intensity of chert microfacies from Peștera Valley.

Dissolution of initial interparticle carbonate cement in a peloidal limestone and precipitation of siliceous cement (correlated with silicification of grains and bioclasts) resulted in a peloidal grainstone chert (microfacies [01] with botryoidal chalcedony cement and silicified peloids). Recrystallization of the initially siliceous ooze with radiolarians formed a radiolarian chert (microfacies [04] with inequigranular xenotopic microcrystalline quartz cement). Silicification of initial carbonate matrix had different outcomes in accordance with depositional fabric and dominant grain types: silicification of matrix and peloids in a carbonate packstone resulted in a peloidal packstone chert (microfacies [02]); silicification of matrix in a detrital-rich limestone produced a detrital-rich chert (microfacies [03]); silicification of a pelagic chalk formed a nodular chert (microfacies [05a] and [05b]).

Mineralogically, chert microfacies identified are composed of silica polymorphs, predominantly microquartz and subordinately chalcedony (sometimes megaquartz), but also minor amounts of other minerals (see Chart 4). One sample contains a higher amount of carbonate fluorapatite (microfacies [03]), suggesting silicification in phosphatized sediments. From a mineralogical point of view, the only clear difference can be observed between the peloidal cherts (microfacies [01] and [02] that contain high amount of chalcedony as intergranular cement (see Table 5, Chart 4) and all other samples that contain low amounts of chalcedony as mold and void infillings. Also, it can be observed (see Cart 4) the association between high amounts of granular microquartz (crypto- and microscrystalline) and chert microfacies with fine-grained textures such as microfacies [04], [05a] and [05b]. This implies that the mineralogical species resulted from the silicification process is fabric selective: granular cryptocrystalline quartz is found as a replacement product in silicified peloids (originally limemud peloids), bioclasts (originally calcite or other carbonates) and in the silicified matrix (originally micrite matrix), the silica precipitation being triggered by decreasing pH levels and calcite dissolution simultaneous with the carbonate silicification[27]; chalcedony and megaquartz are found as early diagenesis precipitation products (cements) in inter- and intragranular pore space (originally filled with calcite or other carbonates, that were dissolved during early stages of diagenesis); granular microcrystalline quartz is found as a recrystallization product in a bedded chert (microfacies [03]) composed of radiolarians and siliceous mud (biogenic opal-A) passed through subsequent silica phases (opal-CT to microquartz) as a consequence of increasing burial temperatures[28].

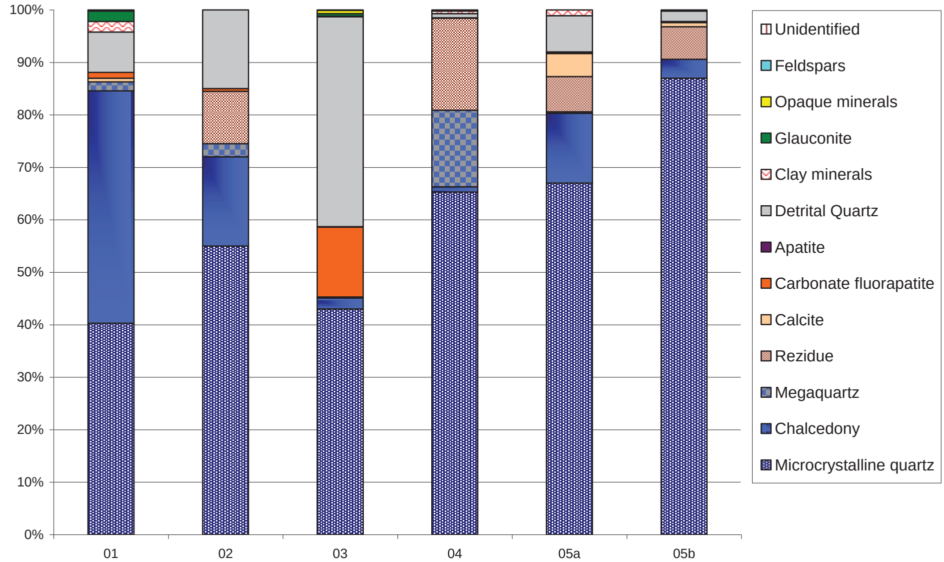

Chart 4 - Mineralogy of chert microfacies from Peștera Valley.

The clear gray-brownish peloidal grainstone chert (microfacies [01]) was identified in archaeological specimens (sample P-DG [02]), in the polymictic breccia as more or less rectangular slabs (sample P-DP [06]), and as *in situ* lenses

[27] KNAUTH 1994, p. 245.
[28] KNAUTH 1994, p. 241.

in the bedded calcareous glauconitic quartz sandstone (P-DP [09]). Samples P-DG [02] and P-DP [06] present external characteristics pointing to very short water transport distances. Considering the *in situ* position of sample P-DP [09], this microfacies is assigned to the Cenomanian stage.

In spite of different depositional fabrics, microfacies [05a] and [05b] contain the same planktonic foraminifera, poorly preserved in many of the samples because of strong to very strong silicification. These foraminifera were identified as pertaining to *Globotruncana* Cushman genus and *Heterohelix* Ehrenberg genus (see Pl. 7), association characteristic of Upper Cretaceous final stages[29]. Considering the sampling context (secondary position in a polymictic breccia, and as archaeological materials), one has to be cautious in linking this Upper Cretaceous chert to Murfatlar Formation (Santonian-lowermost Upper Campanian), but the age indicated by the foraminifera do suggest a connection that should further be investigated. These two chert microfacies are hard to be distinguished macroscopically from each other (Table 2). Given the macroscopic similarities and the fact that they were formed in the same geological deposit, in the same location, and have the same age, they can be considered as a single raw-material variety (only from an archaeological point of view, which is provenance from the same secondary source and the same transport distances).

5. Chert varieties and provenance

Through microfacies analysis, 4 chert varieties were differentiated as raw-materials used for tool production at Peştera-Dealu Guran site, varieties that include microfacies [01], [02], [03], and [05a]+[05b]. This analysis established 3 chert varieties for Peştera-Dealu Peşterica sampling location, including microfacies [01], [04], and [05a]+[05b]. Thus, a positive match was made between the peloidal grainstone and foraminifera cherts from the archaeological site and the sampling location. This implies that the sampled geological deposit (the polymictic breccia from Peştera-Dealu Peşterica) it's probably the source of raw-materials for Dealu Guran site. The other two archaeological varieties might come from the same source but are probably missing from this study due to insufficient sampling of the geological deposit. Provenance of unaccounted varieties from other sources can't be excluded in the current state of research.

External characteristics of archaeological hand specimens indicate different grades of water worn surfaces (Pl. 6, Table 2), ranging from rounded pebbles with neocortex (sample P-DG [12]) to merely abraded chalky and sandy limestone "fresh cortex" specific to the Upper Cretaceous foraminifera nodular chert, and respectively the Cenomanian lenticular chert. These characteristics are consistent with those observed on hand specimens from the polymictic breccia (Pl. 3 and 6, Table 2) containing chert slabs (the Cenomanian lenticular chert) and nodules (the Upper Cretaceous foraminifera nodular chert), but also rounded pebbles of bedded chert (P-DP [07]). These external macroscopic observations strongly suggest and support a connection between the Lower Palaeolithic site and the probable supply source (the polymictic breccia).

The source is local and found exposed on the other side of Peştera Valley

[29] BOUDAGHER-FADEL 2013, p. 67-68, 70-71.

(Dealu Peşterica). This deposit with chert slabs and nodules might have been found on the same side with the archaeological site, but current research hasn't established any locations exposing the full geological sequence on Dealu Guran. Distance between the probable supply source and the archaeological site is shorter than 1 km. Though this isn't a quantitative estimate, based on the external macroscopic features it can be affirmed that the predominant form of raw-material inside the source is the nodular foraminifera chert (with variously shaped and sized blocks from thick plates, spheroids, irregular-oval to rod-shaped and concretionary), followed by the peloidal grainstone chert (found as more or less rectangular slabs of different sizes), while the rounded pebbles are rare and small-sized. Following Alain Turq's classification of supply sources[30], the polymictic breccia from Peştera-Dealu Peşterica can be considered as a sub-autochthonous source: contains materials transported on short distances, found as banks in paleodepressions, with good preservation of cortex on the chert slabs and nodules (from 5 to 20/30 cm long), slightly altered by water (different degrees of water-worn and small flaking scars from water-transport). Although chert pebbles in small amounts were found in this breccia (sample P-DP [07]), they are interpreted as extrabasinal (lithoclasts) content of the initial Upper Cretaceous chalk deposit that is the source of the Uppermost Cretaceous to Lower Tertiary breccia deposit[31]. This kind of sub-autochthonous source might have been exploited from erosion surfaces or landslides.

Regarding the proportions of the raw-materials determined in this study it has to be stated that such estimations were not conducted for the lithic assemblage of Peştera-Dealu Guran. Visual estimate from the time of the sampling and macroscopic analysis suggests that the foraminifera chert is the predominant raw-material used (probably at least 80% or more of the assemblage), followed by the peloidal grainstone chert (at least 19%), while the other two established types of chert (the dertital rich chert and the peloidal packstone chert) represent negligible amounts (say 1%). Proportions of chert varieties used as raw-materials at Dealu Guran reflect the proportions estimated for the supply source (the polymictic breccia), suggesting a raw-material exploitation strategy based on availability rather than preference (such as quality of the raw-material).

The raw-material quality represents a measure of raw-material package size, package shape, and mineralogical structure and purity that characterize the workability of the material (fracture predictability) and edge durability[32]. If the raw-material quality is viewed as a measure of fracture predictability (density and grain size, mineralogy, homogeneity, crystallinity, impurity abundance[33] -, then the foraminifera chert represents an easily workable and high quality siliceous material due to its petrographic characteristics (composed of cryptocrystalline quartz and very fine sand-sized particles, most of them also silicified, with variable shaped and sized nodules). If raw-material quality is

[30] TURQ 2000a, p. 106-107; 2000b, p. 391.
[31] Unit 2 in IOVITA *et al.* 2012, p. 976.
[32] BRANTINGHAM *et al.* 2000, p. 257; BRAUN *et al.* 2009, p. 1607-1608.
[33] BRAUN *et al.* 2009, p. 1607.

considered from the edge durability point of view (grain size, presence of water in the rock, and fracture patterns[34] -, then the peloidal grainstone chert (composed predominantly of fine sand-sized peloids and chalcedony cement) meets the requirements for obtaining flakes or blades with tougher and durable edges. To correctly assess these properties (fracture predictability and durability) additional tests[35] should be performed on the raw-material from Dealu Guran.

The lithic assemblage collected in the excavation of 2011 is composed of flakes (around 40% of them guarding 90-100% cortex area on their surfaces, an just 5% of the flakes have no cortex at all - IOVITA *et al.* 2012, fig. 6A) and cores, but without formal tools (IOVITA *et al.* 2012, p. 981). This suggests that the raw-material was introduced in the site as unprepared blocks (whole nodules and slabs), and probably the tool or blanks were carried out from the site. This pattern of raw-material acquisition is consistent with that of Lower Palaeolithic sites from Africa (Acheulian), where local supply sources (0-10 km) delivered 75-100% of the raw-material used as raw-materials at those sites[36]. Also, the lack of other artefact types (such as bones, charcoal) and the predominance of cortical flakes and cores (evidence of core reduction), suggests that Dealu Guran might represent a "factory site" similar to MNK Chert Factory from Olduvai Gorge (Tanzania), that is a place were a specific activity was carried without evidence of permanent settlement[37], and from where hominids selected a certain size of flakes to be caried in another site[38]. Thus, the supply and reduction strategy of Lower Palaeolithic inhabitants of Dealu Guran is simple and straight forward: the use of available raw-materials from local sources (under 1 km) introduced as unprepared blocks, where they performed the complete sequence of lithic reduction, seeking to obtain blanks and/or tools to be carried out of the site for further use.

6. Conclusions

The employment of microfacies analysis yielded 6 chert microfacies differentiated based on sedimentological and diagenetic traits observed in thin sections, traits that explain their configuration (silicified sediments from shallow and deep marine environments) and strengthen them as valid chert varieties: peloidal grainstone chert, peloidal packstone chert, detrital-rich chert, radiolarian chert, foraminifera chert (with two sedimentary fabrics). This study proved that at least 4 chert varieties were used in Peştera-Dealu Guran site, two varieties being linked to a polymictic breccia deposit (sub-autochthonous source) found within 1 km of the site. The other two varieties may have the same supply source, but this has to be confirmed in the future.

In light of this results, it must be pointed out that Peştera Valley offers a moderate variability of chert varieties, but these are found in considerable amounts in primary deposits (chert lenses in sandy limestone, nodular cherts in

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[34] BRAUN *et al.* 2009, p. 1608.
[35] Described by BRAUN *et al.* 2009.
[36] FÉBLOT-AUGUSTINS 1990, p. 28.
[37] STILES *et al.* 1974, p. 285.
[38] STILES *et al.* 1974, p. 307.

chalk) and in secondary position (polymictic breccia). The pattern of raw-material distribution within the supply source is reflected inside Dealu Guran's lithic assemblage, which shows overwhelming predominance of Upper Cretaceous foraminifera chert and subordinate use of peloidal grainstone chert. From this it can be inferred that Lower Palaeolithic inhabitants of Dealu Guran had a simple and convenient supply strategy: the use of collected chert varieties as were found available in natural openings, introduced inside the factory site as unprepared blocks and reduced with the aim of obtaining blanks and/or tools that were later carried out of the site.

Instead of perpetuating and increasing the confusion around regionally defined siliceous materials such as Balkan flint, Murfatlar flint, Moesian flint and so on and so forth, or worse combining chronostratigraphically different siliceous materials in one single type (Dobrogea chert), efforts should be made towards characterizing and classifying any type, subtype, variety and subvariety of such materials. Otherwise, inferences regarding supply sources, transport distances and exchange routs resulted from regional cherts types (based on macroscopic and mineralogical features) are basically useless.

Although this is just a small-scale study and its results are valid to a localized context, microfacies analysis (combined with other investigation techniques) might prove to be the proper way of characterizing and classifying chert varieties and trace their provenance in this and other areas.

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Table 1. Lower Cretaceous to Miocene lithostratigraphic units of Southern Dobrogea (after CHIRIAC 1968, AVRAM *et al.* 1993; ION *et al.* 2000-2001; MELINTE 2006) and lithostratigraphic units of Peştera-Dealu Peşterica (after IOVITA *et al.* 2012).

Lithostratigraphic units in Southern Dobrogea			**Litostratigraphic units on Peştera-Dealu Peşterica**	
Sarmatian shallow semi-closed marine facies	sands or conglomerates, overlain by an interbeded succession of organogenic limestones, calcarenits, oolitic limestones, sands and marls;		Fossiliferous sandy limestone (unit 6); Orange sandy limestones (unit 5); Green calcareous glauconitic sandy clays (unit 4); Weathered, unconsolidated transgressive sandy limestone of mottled orange-green color, containing flints and gravels at the base (unit 3);	
Uppermost Cretaceous to Lower Tertiary	-		Strongly weathered white kaolinitic sandstone, representing terrestrial tropical weathering and reworking of older units following marine regression (unit 2);	
Latest Campanian-Late Maastrichtian (Nisipari Formation) marine nearshore facies and marine offshore facies	interbeded chalky marls and clays, chalky glauconitic sands/sandstones and massive chalky limestones;	lower Maastrichtian (Nazarcea Formation) continental-lacustrine facies;	reddish marls, gray-yellowish marls and clays (variegated clayey and marly succession), as well as kaolinitic clays (16-45 m thick);	-
Santonian-lowermost Upper Campanian (Murfatlar Formation) marine offshore facies and near shore facies	c) white, massive or bioturbated chalk with chert (35 m thick), rich in planktonic and benthonic foraminifers and in nannoplankton; b) massive friable sandstones or chalky quartzose-glauconitic sand, locally displaying parallel lamination or intense bioturbation; a) basal conglomerate made up of quartz and quartzite, Jurassic-Valanginian limestone, greenshist pebbles, fragments of phosphatized ammonites in a grit-limestone matrix;			-
Early Cenomanian (Peștera Formation) marine near shore facies	e) strongly bioturbated chalky quartzose sandstones rich in benthonic foraminifers; d) the chalk unit - slightly glauconitic, gritty and, in places, argillaceous chalk, with benthic foraminifera (*Textulariaceae*) and planktonic foraminifera (*Hedbergelidae*, *Praeglobotruncanidae*, *Rotaliporidae*); c) the quartzose-glauconitic chalky sandstone unit (most fossiliferous); b) the gritty-sandy unit - well-washed sands and sandstones with lenses of quartzose- or quartz-glauconitic microconglomerates, low to very low angle tabular planar cross-lamination and subordinately parallel lamination; a) the basal conglomerate - detrital quartz or quartzite and phosphate grains, and fragmented, partly or totally phosphatized fauna encompassed in a whitish gritty-chalky glauconitic matrix (a quartzo-phosphatic marine placer);			Bedded calcareous glauconitic quartz sandstones with flint lenses, representing a shallow marine environment (unit 1);
Uppermost Aptian-Albian (Cochirleni Formation) marine on-shore facies	condensed and strongly phosphatized thin (1-2 m) successions of highly organic sandstone, lumachelle and quartzose-glaucontic clayey sandstones and sands; sandstone succession with irregularly-shaped bodies of clayey sands; glauconitic-quartzose clayey sands with discontinuous to continuous interbeds of glauconitic-quartzose sandstones (30-35 m thick), in places including loose or indurated quartzose-phosphatic micro-pebbles or micro-conglomerates;			-
Middle-Upper Aptian (Gherghina Formation) fluvio-lacustrine facies	random successions of pebbles or conglomerates and sands or poorly consolidated sandstones, slightly coherent sandy kaolinitic clays and, locally, carbonaceous clays with sporadic coal intercalations;			-

Table 2. Macroscopic characteristics of chert microfacies from Peștera Valley.

No.	Chert microfacies	Sample code	Structure	Fracture	Luster	Transparency	Color	Macroscopic aspect
01	peloidal grainstone chert	P-DP [09], P-DP [06], P-DG [02]	Lenticular	conchoidal	dull	very translucent	clear gray-brownish	granulated, porous, clear gray-brown, white laminae
02	peloidal packstone chert	P-DG [12]	Nodular	conchoidal	dull	opaque	rusty	chaotically zoned (gray and rusty areas)
03	detrital-rich chert	P-DG [05]	Thinly laminated	conchoidal	greasy	translucent	gray-brownish	paralell zonation (light gray with thin brown areas)
04	radiolarian chert	P-DP [07]	Thinly laminated	conchoidal	dull	opaque	very dark gray	laminated (alternating clear gray and dull dark gray laminae)
05a	foraminifera cementstone chert	P-DG [04], P-DG [06], P-DP [02], P-DG [07], P-DP [03], P-DP [05], P-DG [08], P-DG [11], P-DG [13]	Nodular	conchoidal	greasy	translucent	brownish	spotted (white carbonate reminiscences)
05b	cementstone chert	P-DG [09], P-DP [08], P-DP [01a], P-DP [01b]	Nodular	conchoidal	greasy	translucent	brownish	spotted (white carbonate reminiscences)

Table 3. Depositional and diagenetic fabric of chert microfacies from Peștera Valley.

No.	Chert microfacies	Support	Depositional fabric	Diagenetic fabric	Characteristic fossils
01	peloidal grainstone chert	grain-supported	grainstone	compacted, silicified peloidal grainstone	Echinoderms and benthic foraminifera
	siliceous quartzarenite	grain-supported	packstone	siliceous quartz arenite	
02	peloidal packstone chert	grain-supported	packstone	compacted, silicified peloidal packstone	Echinoderms, sponge spiclues, bivalves and radiolarians
03	detrital-rich chert	matrix-supported	wackestone	detrital-rich siliceous cementstone	Echinoderms, ostracodes, benthic foraminifera
		matrix-supported	wackestone	siliceous quartzwacke	
		grain-supported	packstone	siliceous quartzarenite	
04	radiolarian chert	matrix-supported	wackestone	recrystallized radiolarian siliceous ooze	Radiolarians and sponge spicules
		matrix-supported	mudstone	recrystallized siliceous ooze	
		matrix-supported	mudstone	silicified micrite	
05a	foraminifera cementstone chert	matrix-supported	wackestone	silicified biomicrite	Planktonic foraminifera, sponge spicules, echinoderms, radiolarians
		matrix-supported	mudstone	silicified micrite	
05b	cementstone chert	matrix-supported	mudstone	silicified fossiliferous micrite	Planktonic foraminifera, sponge spicules and radiolarians
		matrix-supported	wackestone	silicified fossiliferous micrite	

Table 4. Depositional settings and classification chert microfacies from Peștera Valley.

No.	Classification in this study (Chert Microfacies)	after Dunham (1962)	after Folk (1962)	Facies Zone	Standard Microfacies	Depositional setting	Marine environment	Age
01	peloidal grainstone chert	peloidal grainstone	pelsparit	FZ 8	SMF 16-Non-laminated	restricted platform interior	shallow-water	K2
02	peloidal packstone chert	peloidal packstone	poorly washed pelsparit	FZ 8	-	restricted platform interior	shallow-water	-
03	detrital-rich chert	-	-	FZ 2	-	deep shelf	deep-water	-
04	radiolarian chert	-	-	FZ 1	SMF 3-Rad	cratonic basin	deep-water	-
05a	foraminifera cementstone chert	foraminifera wackestone	sparse biomicrite	FZ 1	SMF 3-For	cratonic basin	deep-water	K2
05b	cementstone chert	foraminifera mudstone	fossiliferous micrite	FZ 1	SMF 3-For	cratonic basin	deep-water	K2

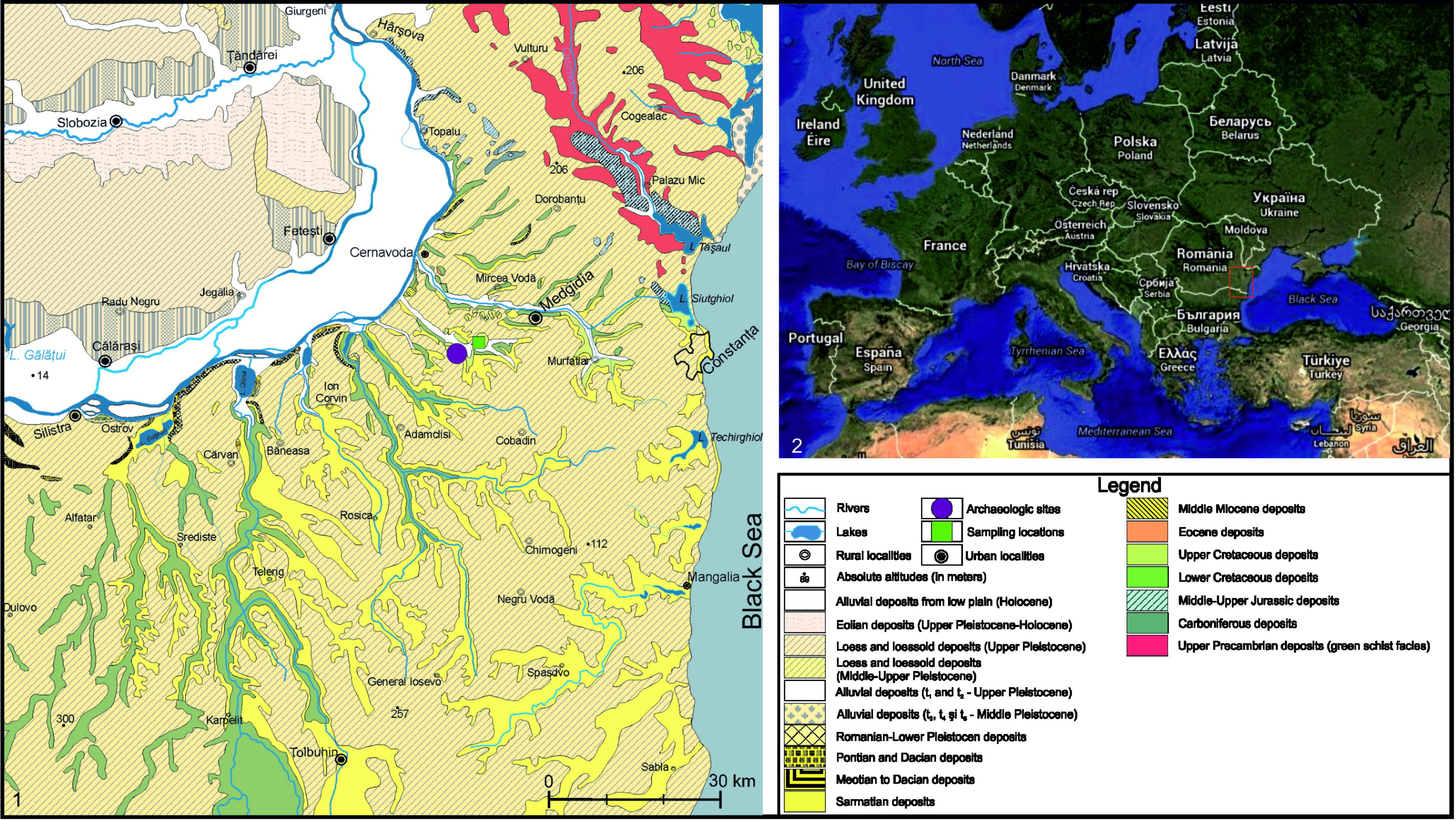
Table 5. Groundmass composition of chert microfacies from Peștera Valley.

No.	Chert microfacies	Ground mass	Matrix		Cement	InterPartCem		PoreLiningCem		CavCem		FracCem		Replacement	
01	peloidal grainstone chert	40,4%	-	0,0%	40,4%	Qf-By	35,4%	Qf-Fb/+MQ	5,0%	-	0,0%	-	0,0%	-	0,0%
	silicified quartzarenite	14,0%	micrite	1,0%	13,0%	Qf-By	10,0%	Qf-Fb/+MQ	3,0%	-	0,0%	-	0,0%	-	0,0%
02	peloidal packstone chert	25,5%	micrite	10,0%	15,5%	-	0,0%	Qf-Fb	5,0%	-	0,0%	-	0,0%	Qcc	10,5%
03	detrital-rich chert	69,4%	micrite	10,0%	59,4%	-	0,0%	Qf-Fb	1,0%	-	0,0%	-	0,0%	Qcc	58,4%
		52,8%	micrite	10,0%	42,8%	-	0,0%	-	0,0%	-	0,0%	-	0,0%	Qcc	42,8%
		30,2%	micrite	2,5%	27,7%	-	0,0%	-	0,0%	-	0,0%	-	0,0%	Qcc	27,7%
04	radiolarian chert	82,7%	rezidue	17,5%	65,2%	Qm-IneXeno	65,2%	-	0,0%	-	0,0%	-	0,0%	-	0,0%
		98,2%	rezidue	22,5%	75,7%	Qm-IneXeno	75,7%	-	0,0%	-	0,0%	-	0,0%	-	0,0%
		95,9%	micrite	30,0%	65,9%	-	0,0%	-	0,0%	-	0,0%	-	0,0%	Qcc	65,9%
05a	foraminifera cementstone chert	73,9%	micrite	6,7%	67,2%	-	0,0%	-	0,0%	Qf-By/+MQ	0,7%	Qf-Fb	0,2%	Qcc	66,3%
		95,6%	micrite	5,0%	90,6%	-	0,0%	-	0,0%	-	0,0%	-	0,0%	Qcc	90,6%
05b	cementstone chert	93,2%	micrite	6,2%	87,0%	-	0,0%	-	0,0%	-	0,0%	-	0,0%	Qcc	87,0%
		86,0%	micrite	7,5%	78,5%	-	0,0%	-	0,0%	-	0,0%	-	0,0%	Qcc	78,5%

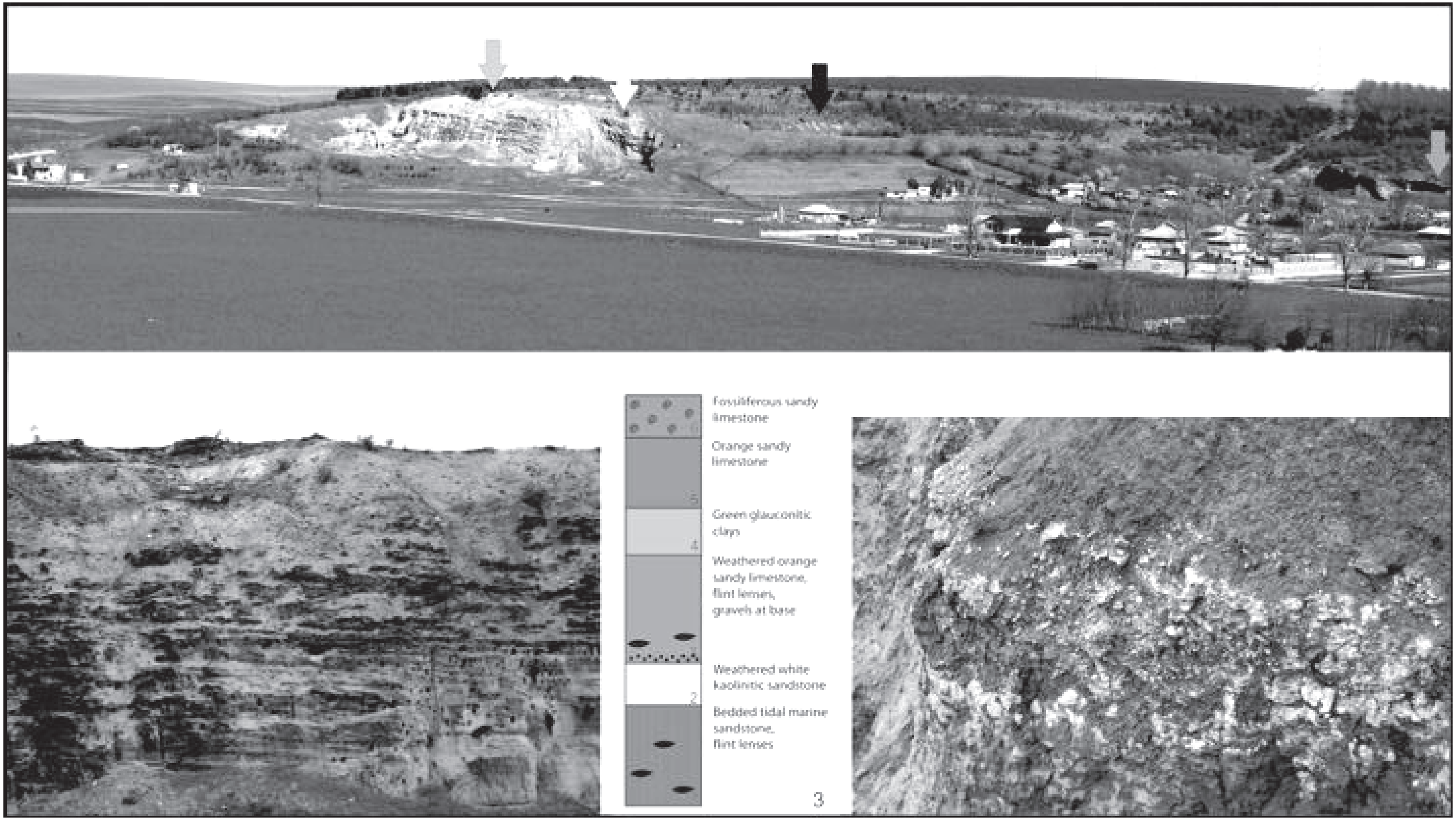
Groundmass – the combined amount of matrix and cement; Matrix - interstitial material mechanically deposited between larger grains (Flügel 2010: 73); micrite - the fine-grained matrix (1-4 μm) of carbonate rocks and the fine-grained constituent of carbonate grains (Flügel 2010: 75); residue – material not dissolved and not replaced by silica;

InterPartCem – interparticle cement; PoreLiningCem – pore lining cement; CavCem – cavity cement; FracCem – Fracture cement;

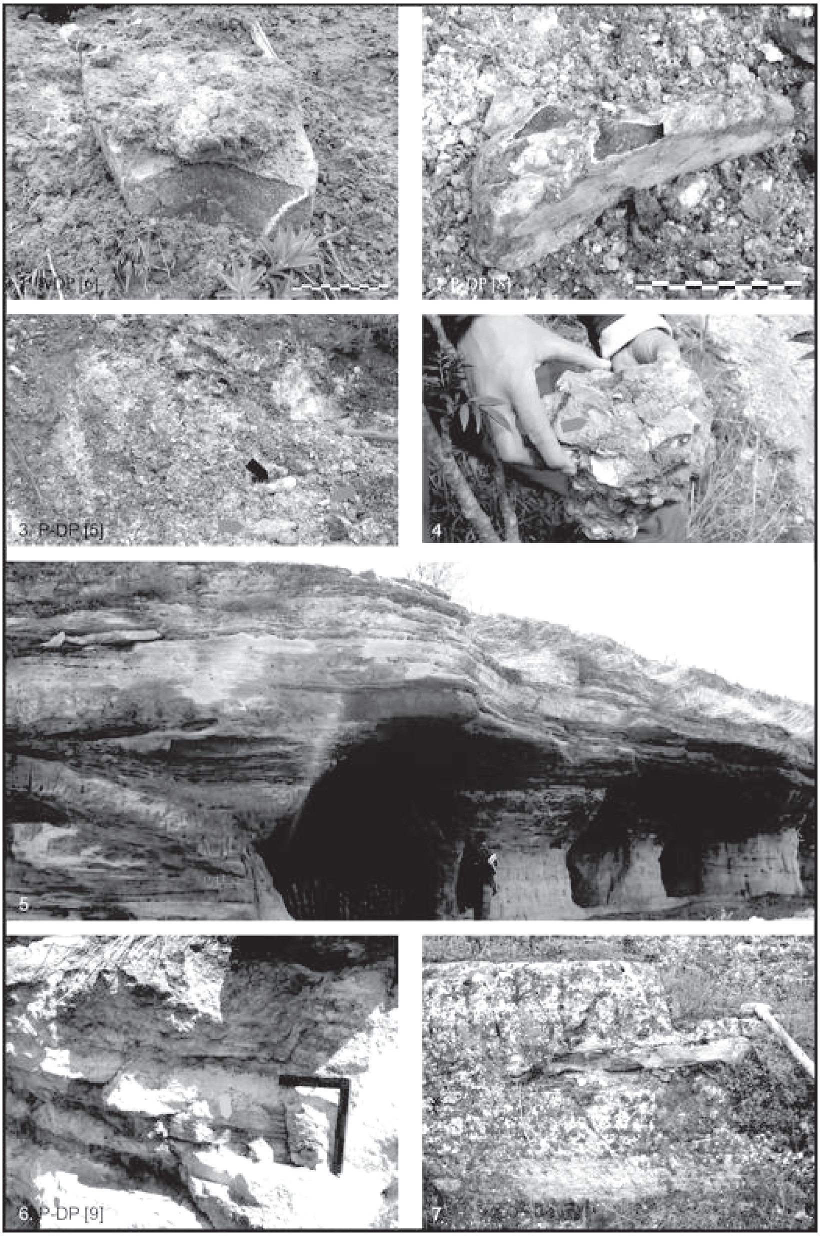
Qf-By – botryoidal chalcedony cement; Qf-Fb – fibrous chalcedony cement; Qcc – granular cryptocrystalline quartz cement; Qm-Ineq-Xeno – inequigranular xenotopic recrystallized microcrystalline quartz cement (introduced under "InterPartCem" category, but representing a recrystallization product); MQ – drusy megaquartz cement.



Pl. 1 - General setting of Peștera Valley: 1. Location of Peștera-Dealu Guran site and Peștera-Dealu Peșterica sampling location in the study area (digital map redrawn after Geological Map of Romania 1: 1000000, 1978, with modification); 2. Regional setting of the study area (red rectangle; map from www.maps.google.com).



Pl. 2 - Geological setting of samples collected from Peştera-Dealu Peşterica: 1. W-SW view of the right side of Peştera Valley, yellow arrow points to the profile in the second photo, white arrow indicates the profile in the last photo, black arrow the location of samples P-DP [1-8], and gray arrow the caves (Peşterici) and the location of sample P-DP [9]; 2. Profile showing the Cretaceous-Miocene sequence; 3. Geological sequence of Dealu Peşterica (after IOVITA *et al.* 2012, p. 976); 4. Detail profile of units 2 and 3; photos by Al. Ciornei (2011).



1 2 3 4 5 6 7

Pl. 3 - Geological context of samples collected from Dealu Peşterica: 1. Gray-brownish chert slab (sample P-DP [6]), scale is 10 cm; 2. Flat nodule of brown-chocolate chert (sample P-DP [8]), scale is 10 cm; 3. Small nodules of chert (gray arrows) and sample P-DP [5] (black arrow), adze is 25 cm; 4. Breccia block with flakes or parts of nodular chert; 5. View of the bedded calcareous glauconitic quartz sandstone (unit 1) at Peşterici location, scale is about 1.80 m in height; 6. Chert lenses in unit 1 and the position of sample P-DP [9] (arrow), scale is 15 cm; 7. Another chert lens, a few meters above and to the right from sample P-DP [9], adze is 40 cm; photos by Al. Ciornei (2011).

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3 6

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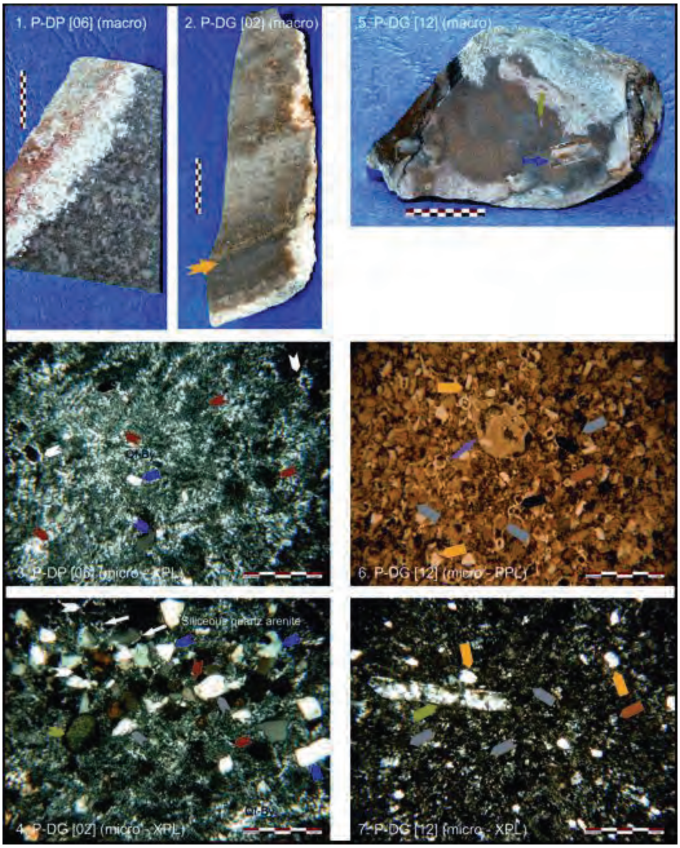
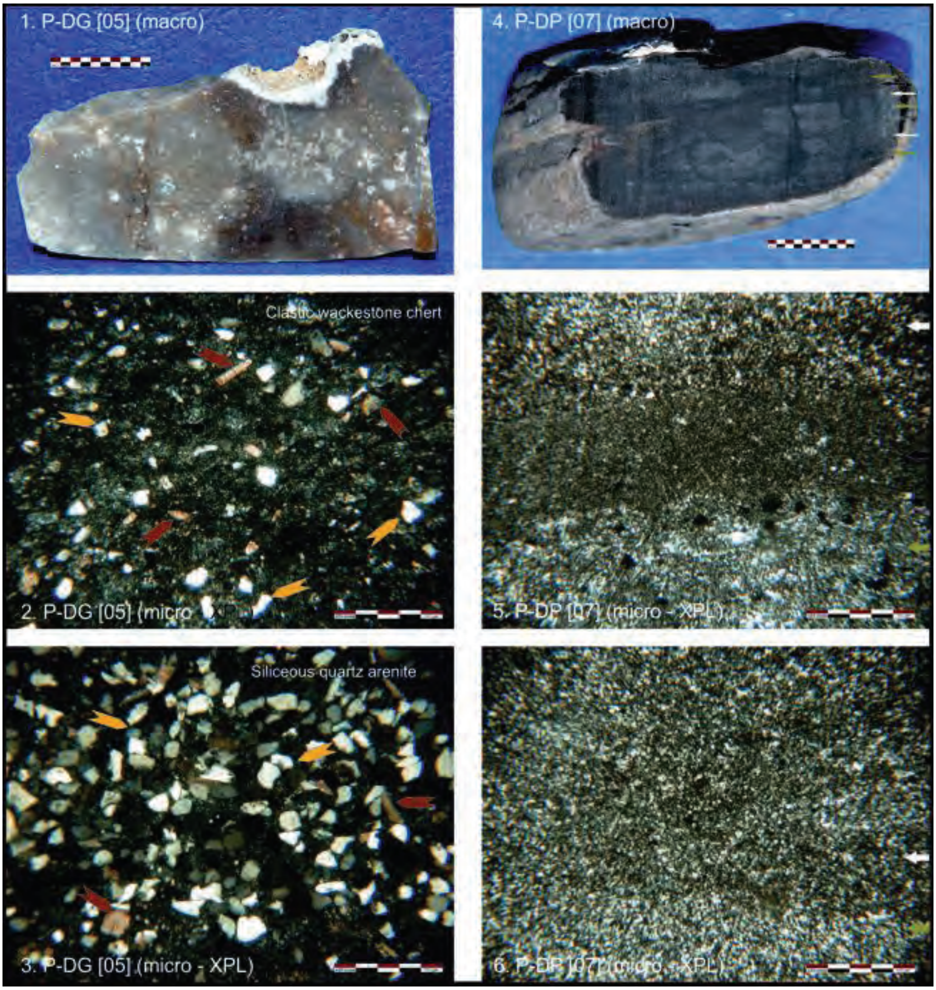


Pl. 4 - 1-4: Peloidal grainstone chert from Peştera Valley (microfacies [01], FZ 8, restricted platform interior): clear gray-brownish color with a porous and granulated aspect and point-like white carbonate reminiscences, dull, very translucent; this microfacies has grainstone depositional fabric, slightly compacted, composed of silicified limemud peloids (red arrows), silicified echinoderm plates (black arrow), rare benthic foraminifera (light blue arrow), and quartz grainclasts (blue arrows) encompassed in a botryoidal chalcedony cement (Qf-By); some samples (P-DG [02]) exhibit gray-whitish laminae (yellow arrow) representing thin accumulations of siliceous quartz arenite, composed of quartz grainclasts (blue arrows), feldspar grainclasts (gray arrows), silicified limemud peloids (red arrows), glauconitic peloids (green arrow), with interparticle pores lined by fibrous chalcedony cement (white arrows); 5-7. Peloidal packstone chert from Peştera Valley (microfacies [02], FZ 8, restricted platform interior): rusty color with very tiny white carbonate reminiscences, dull and opaque; this microfacies is composed of relatively well sorted silicified limemud peloids (gray arrows), quartz grainclasts (yellow arrows), sponge spicules (orange arrows, transversal sections), fragmented bivalve shells (green arrows), very large echinoderm plate (blue arrow), and benthic foraminifera (purple arrow), enclosed in a partially silicified matrix (cryptocrystalline quartz cement), with interparticle porosity, wall-lined by fibrous chalcedony cement (black arrows); packstone depositional fabric, compacted with many tangential and linear contacts between particles; 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).



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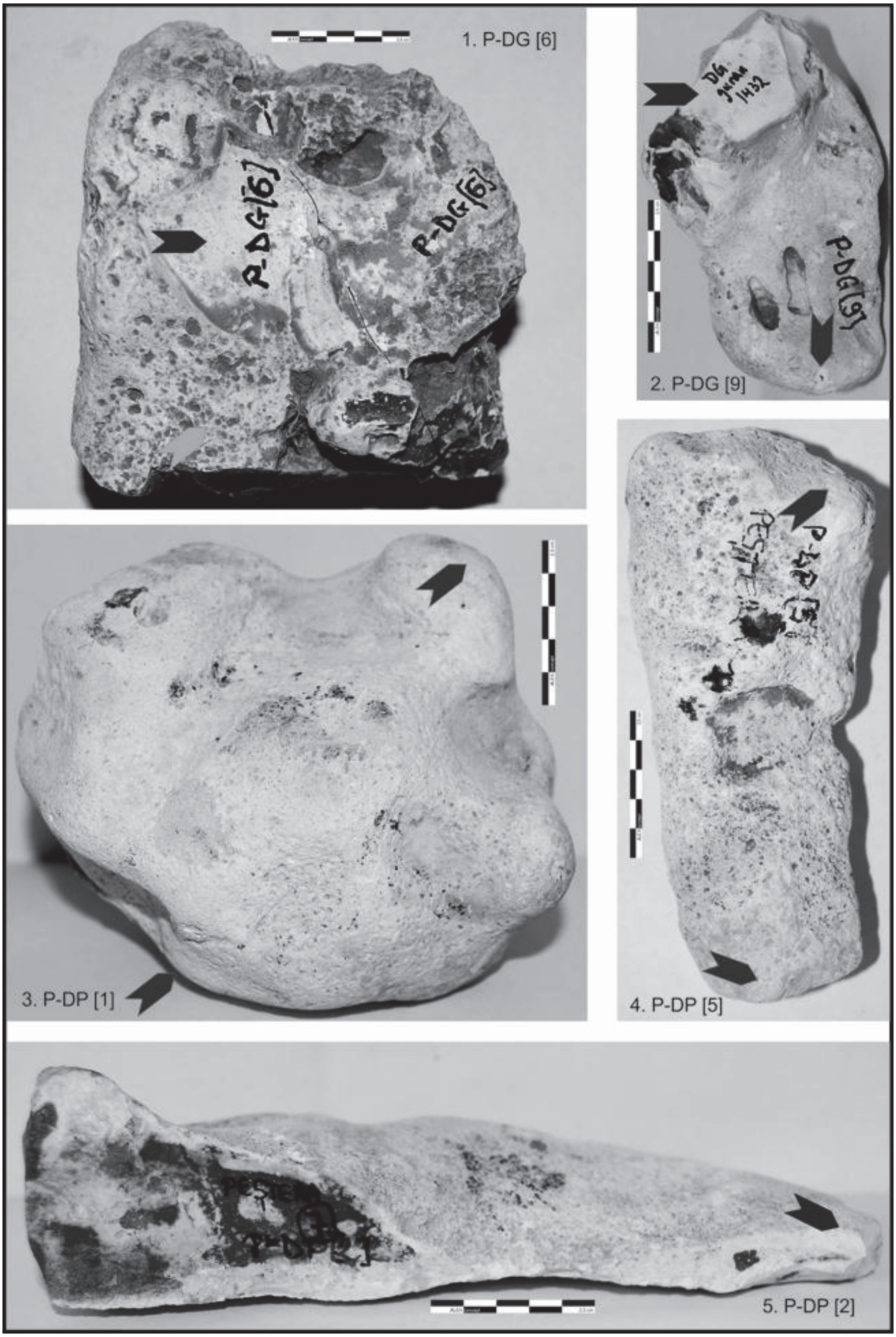
Pl. 5 - 1-3: Detrital-rich chert from Peştera Valley (microfacies [03], FZ 2, deep shelf): gray-brownish color, greasy luster, translucent; this microfacies is composed of two zones with wackestone fabric, dominated by quartz grainclasts (yellow arrows, from 20% to 45%), and a siliceous quartz arenite zone; all zones have a parallel distribution and a constant amount of phosphatized fragmented echinoderm plates (red arrows), sponge spicules and rare foraminifera, enclosed in a silicified matrix (cryptocrystalline quartz cement); 4-6. Radiolarian chert from Peştera Valley (microfacies [04], FZ 1, cratonic basin): dark gray (alternating clear gray and dull dark gray laminae), dull and opaque; this bedded chert displays alternating laminae of radiolarian wackestone (green arrows, radiolarians and inequigranular xenotopic microcrystalline quartz cement), silicified micrite (black arrow, granular cryptocrystalline quartz cement) and siliceous mudstone (white arrows, inequigranular xenotopic microcrystalline quartz cement); the hand sample presents macroscopic traces of water-transport (rounded pebble with a neocortex); macro photos – scales are 1 cm; micro photos - scales are 500 µm; XPL - cross-polarized light; photos by Al. Ciornei (2013).



Pl. 6 - External view of nodular chert from Peştera, with white-yellowish chalk cortex (yellow arrow), whitish alteration surfaces interpreted as weathered water-transport flaking scars (gray arrows), and flaked and abraded corners also interpreted as water transport marks (red arrows); scales are 2.5 cm; photos by Al. Ciornei (2013).

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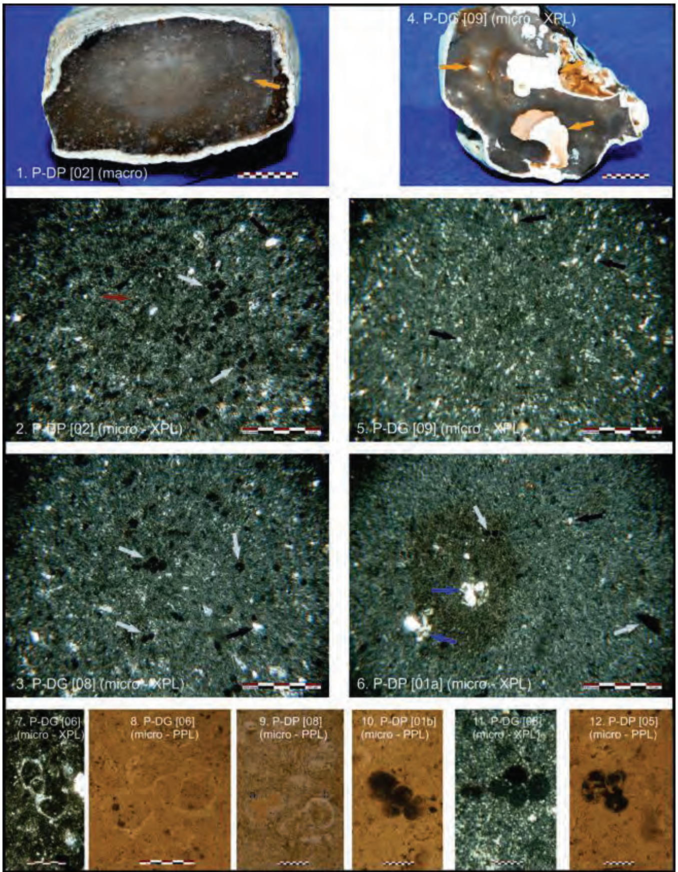
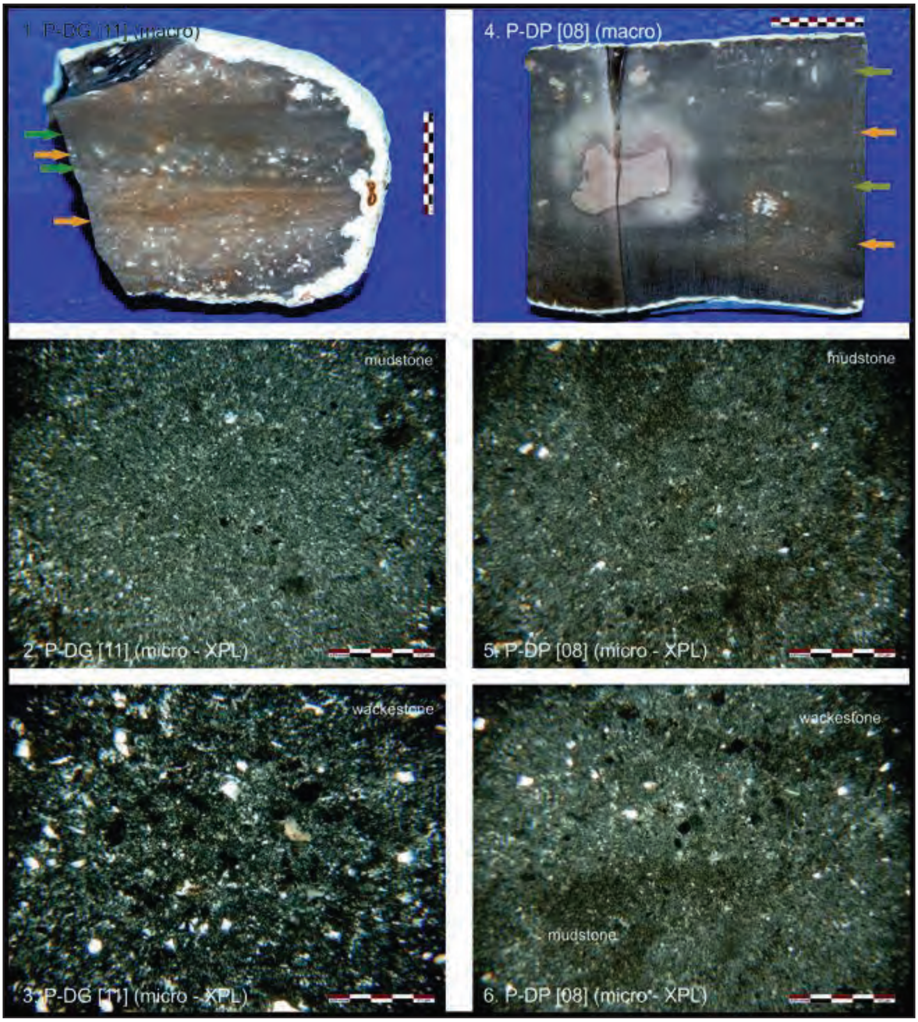
7-12



Pl. 7 - 1-3: Foraminifera cementstone chert from Peştera Valley (microfacies [05a], FZ 1, cratonic basin): light to dark chocolate-brown color, greasy luster, translucent, spotted look given by whitish undissolved chalk (yellow arrows) inside the chert nodule (abundant point-like chalk reminiscences); this microfacies is characterized by its wackestone fabric with abundant planktonic foraminifera (gray arrows), a considerable amount of quartz grainclasts (black arrows), and rare clay grainclasts (red arrows), enclosed in a fully silicified matrix (cryptocrystalline quartz cement); 4-6. Cementstone chert from Peştera Valley (microfacies [05b], FZ 1, cratonic basin): chocolate-brown color, greasy luster, translucent, with white carbonate reminiscences (less abundant than the previous microfacies); mudstone depositional fabric with rare planktonic foraminifera (gray arrows), rare benthic agglutinated foraminifera (blue arrows), and low siliciclastic input (black arrows); 7-8. Axial sections through foraminifera from *Globotruncana* Cushman genus (*Globotruncanidae* family, superfamily Globigerinoidea); genus range from Late Coniacian to Maastrichtian (BOUDAGHER-FADEL 2013: 67-68); 9-12. Transversal (9a), longitudinal (9b) and axial (10-12) sections through foraminifera from *Heterohelix* Ehrenberg genus (family Heterohelicidae, superfamily Heterohelicoidea); genus range from Late Albian to Maastrichtian (BouDagher-Fadel 2013: 70-71); macro photos - scale is 1 cm; micro photos 2-3 and 5-6 - scales are 500 μm; micro photos 7-8 - scales are 250 μm; micro photos 9-12 - scales are 100 μm; XPL - cross-polarized light; PPL - plane-polarized light; photos by Al. Ciornei (2013).



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Pl. 8 - Foraminifera cementstone chert (1-3, microfacies [05a]) and cementstone chert (4-6, microfacies [05b]) of Peştera Valley with alternating laminae of wackestone (yellow arrows) and mudstone (green arrows) fabrics; siliciclastic input of mudstone fabric from microfacies [05a] has the same values as that from the microfacies [05b]; siliciclastic input of wackestone fabric from microfacies [05b] is consistent with that of microfacies [05a]; mudstone laminae tend to have a more clearer and darker shade; macro photos - scale is 1 cm; micro photos - scale is 500 μm; XPL - cross-polarized light; photos by Al. Ciornei (2013).