PETROGRAPHIC ANALYSIS OF RAW MATERIALS FROM LESPEZI-LUTĂRIE: IMPLICATIONS FOR UPPER PALAEOLITHIC SITES FROM THE MIDDLE AND LOWER BISTRIȚA VALLEY

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Keywords: petrographic analysis, raw material characterization, Middle and Lower Bistrița Valley, Upper Palaeolithic.

Abstract: This study presents the petrographic analysis of lithic raw materials from level IV of Lespezi-Lutărie site (Upper Palaeolithic, Lower Bistrița Valley, Bacău County, Romania), resulting in the identification of 16 varieties related to different rock types: sandstones (quartzarenites, calcarenite), black shale, bedded cherts (Early Oligocene menilite and detrital-rich spiculite chert), peloidal cherts, Eocene and Cretaceous nodular cherts. Part of the varieties identified reflect the availability, abundance, accessibility and variability of raw materials in the surrounding area (Tarcău and Vrancea nappes), while the ones brought in from other regions represent imported materials related to cultural relations and geographically available circulation routes between Gravettian communities from the Bistrița, Prut and Danube valleys. The use of both coarser (sandstones) and fine-grained lithologies (shale, cherts), from poorly silicified (sandstones, shale) to strongly and very strongly silicified (cherts from chalk) reflects acquisition patterns guided by specific needs and uses of tools. External macroscopic features indicate secondary sources (alluvial deposits, riverbeds) for all varieties determined.

Cuvinte-cheie: analiza petrografică, caracterizarea materiilor prime, Valea Bistriței mijlocii și inferioare, Paleolitic Superior.

Rezumat: Acest articol se concentrează pe determinarea tipurilor de materii prime reprezentate în industria litică de la Lespezi-Lutărie (jud. Bacău, România), sit aparținând Paleoliticului Superior de pe Valea Bistriței inferioare. Analiza petrografică s-a desfășurat pe un lot de piese selectate din nivelul IV al sitului, determinarea tipurilor de materii prime fiind bazată pe observațiile macroscopice (culoare, textură, spărtură, luciu, transluciditate) și microscopice (constituenți primari, tipuri de fosile și abundența lor, mineralogie, textură, fabric sedimentar și diagenetic). Observațiile macroscopice au permis separarea mai multor categorii generale de materii prime (gresii, șist negru, menilit, silicolite cenușii, silicolite nodulare din cretă), fiecare cu mai multe varietăți distincte vizual. Analiza microscopică a 20 de secțiuni subțiri a validat categoriile generale de materii prime, permițând caracterizarea de detaliu a 16 varietăți. Probele atribuite categoriei „gresii" sunt reprezentate de două varietăți de arenit cuarțitic cu glauconit (probele Le-Lu [03], [05], și Le-Lu [04]), o varietate de calcarenit (proba Le-Lu [02]) și una de silicolit spiculitic-detritic (Le-Lu [01]). Probele incluse în categoria șist negru s-au dovedit a fi un silicolit peloidal negricios (Le-Lu [06]), un șist argilos negricios (Le-Lu [07]) și un șist calcaros cenușiu-negricios silicifiat (Le-Lu [08]). Probele considerate ca menilit (Le-Lu [09] și [11]) reprezintă un tip de silicolit stratiform cu aspect dungat, compus din benzi subțiri de wackestone bioclastic și benzi subțiri de arenit cuarțitic, care a fost atribuit Oligocenului (Formațiunea Menilitelor Inferioare) pe baza unui specimen de foraminifer bentonic din genul *Nummulites* Lamarck. Categoria silicolitelor cenușii este compusă din două tipuri diferite: un silicolit bioclastic bogat în cuarț detritic (probele Le-Lu [12], [13] și [14]) atribuit Eocenului pe baza unor exemplare de foraminifere planctonice din genul *Morozovella* McGowran (probabil din Formațiunea Calcarelor de Doamna); un silicolit cu foraminifere planctonice abundente (Le-Lu [10]), pe baza cărora a fost atribuit Cretacicului superior. În categoria silicolitelor nodulare din cretă (probele Le-Lu [15]-[20]) au fost diferențiate șase varietăți ce reflectă condiții diferite de sedimentare într-un mediu marin de apă adâncă (șelf extern) și au fost atribuite Cretacicului superior pe baza exemplarelor de foraminifere planctonice. Pe baza caracteristicilor externe ale probelor analizate (aspectul cortexului relevând grade diferite de rulare și transport de către ape) s-a pus în evidență faptul că aceste materii prime au fost colectate din surse aluviale (depozite de pietrișuri). Diversitatea petrografică reflectă ocurența naturală a acestor varietăți în depozitele geologice din constituția pânzelor de Tarcău și Vrancea, ocurență dublată de prezența acestor varietăți în diferitele depozite aluviale de pe râurile și pâraiele care străbat Carpații Orientali în zona de studiu. Ținând cont de ocurența locală a celor mai multe dintre acestea, se poate afirma că aprovizionarea cu materii prime a sitului de la Lespezi-Lutărie s-a realizat din surse aluviale locale (sub 50 km). Absența silicolitelor nodulare din crete în zona de studiu și comparația cu datele publicate anterior pentru zona Moldovei și sudului României, a condus spre idenficarea probelor Le-Lu [15–20] ca fiind silicolite nodulare aduse din surse îndepărtate, precum Valea Prutului mijlociu (150 km) și Valea Dunării inferioare (380–400 km). Acest studiu a pus în evidență faptul că tipurile de materii prime diferențiate anterior (gresii, șist negru, menilit, silicolite nodulare) au o mai mare diversitate petrografică și o proveniență variată.

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INTRODUCTION

The archaeological research of the Palaeolithic sites from the Bistriţa Valley (Eastern Carpathians, Neamţ and Bacău counties, northeastern Romania) goes as far back as 1955 (Nicolăescu-Plopşor, Petrescu-Dîmboviţa 1959, p. 45), being initiated due to the dam construction for the Bicaz hydro-power plant and the future flooding of the Bistriţa segment between Poiana Teiului and Bicaz (which became in 1959–1960 Izvorul Muntelui Lake/Bicaz Accumulation Lake). The Răpciuni (Ceahlău) Basin has been the focus of archaeological research for more than 60 years (Nicolăescu-Plopşor *et alii* 1966, p. 5–7; Păunescu 1998, p. 17–21, 110), first through the extensive rescue excavations between 1955 and 1958 (coordinated by C. S. Nicolăescu-Plopşor and M. Petrescu-Dîmboviţa), and subsequently through the more limited excavations and field surveys from 1962 (M. Drăgotescu), 1979–1984 (Fl. Mogoşanu and M. Matei), and 1980–1986 (Al. Păunescu).

These investigations revealed a great Upper Palaeolithic human occupation density (around 23 sites) in a restricted area (Pl. 1), located only on the right side of the Bistriţa Valley (Păunescu 1998, p. 114). Most of these sites were multi-layered and contained, beside the lithic assemblage, a wealth of combustions structures and bone fragments, some with just a hearth or two and a small amount of bone and lithic flakes, while others contained just a few lithic items and nothing else. Downstream from the Ceahlău Basin, field surveys and more or less limited archaeological excavations taking place between 1963 and 1989 led to the discovery of other Upper Palaeolithic sites (herein UP sites), but just a handful when compared to the above mentioned river sector (Păunescu 1998, p. 17–21). Upstream from the Ceahlău Basin, the archaeological investigations indicated the absence of any Palaeolithic sites.

More recent systematic and interdisciplinary investigations at Poiana Cireşului (1998, 2001–2007, and 2010–2011, see Cârciumaru *et alii* 2006, p. 319; 2007a, p. 5–7; 2007b, p. 263–265; 2008, p. 224–225; 2010a, p. 209; 2011, p. 100–101; 2012, p. 100–103), Bistricioara-Lutărie, Bistricioara-Lutărie La Mal (new site), and Ceahlău-Dârţu (2006–2008, see Steguweit 2009, p. 34–36; Steguweit *et alii* 2009, p. 143–151), but also at Buda-Dealu Viilor and Lespezi-Lutărie (2012–2014, see Dobrescu *et alii* 2013a, p. 30; 2013b, p. 85–86; 2014a, p. 32–33; 2014b, p. 81–82), have allowed the re-evaluation of the lithic assemblages and the chronological and cultural framework of the UP sites from the Bistriţa Valley.

In all sites discovered on the Middle and Lower Bistriţa Valley, raw materials making-up the largest part of the lithic assemblages were recognized as menilite, Audia black schist, glauconitic siliceous sandstone, and flint (initially only Prut Valley flint/Cretaceous flint, and later other varieties), while additional rock types (hard blackish sandstone with bluish chalk-like weathered surface, radio-larite, opal, green/red jasper, spongolithic chert, quartz sandstone, quartzite, yellow or yellowish-brown marlstone, dull blackish obsidian) were used in smaller amounts (Nicolăescu-Plopşor, Petrescu-Dîmboviţa 1959, p. 48, 52; Nicolăescu-Plopşor *et alii* 1966, p. 20; Bitiri, Căpitanu 1972, p. 48–65; Bitiri-Ciortescu *et alii* 1989, p. 27, table 1; Păunescu 1998, p. 102–313; Cârciumaru *et alii* 2006, p. 323; 2007a, p. 11; Steguweit *et alii* 2009, p. 142, 144; see also Table 1). Other than some flint types (from the Prut and Dniester valleys), most of these rock types are common in this region and were described and mentioned in the geological literature, and thus considered as local raw materials. Also, an increase in the exploitation of Prut/Cretaceous flint and menilite in the Gravettian levels was noted in comparison with the Aurignacian ones (Nicolăescu-Plopşor *et alii* 1966, p. 23; Păunescu 1998, p. 47; Steguweit *et alii* 2009, p. 144).

The majority of these determinations, especially those for flint varieties, were based on their macroscopic features and the experience of the archaeologists who were active in more than one region of Romania. A review of the archaeological literature from the early years of investigations till the present day reveals that for the Moldavia region there are just a few raw material studies: the determinations made by the geologist Th. Joja for the raw materials used in UP sites from Ceahlău Basin, identifying the geological age of siliceous sandstone, black schist (Lower Cretaceous) and menilite (Oligocene) and the closest outcropping areas of such materials (Nicolăescu-Plopşor *et alii* 1966, p. 20, note 17); the petrographic bulletins made by Clarissa Papacostea (Păunescu 1970, p. 217–226), going from 1957 till the end of 1960's and only partially published (Păunescu 1998, p. 49, footnote 157), include samples from prehistoric sites located in Ceahlău Basin, Prut Valley and other regions of Romania, based on a mine-ralogical-orientated thin section analysis which allowed this researcher to characterize many types of rocks used as raw materials; the only thoroughly petrographic analysis of the Middle Prut Valley flint was carried out by A. Muraru (1990), remaining ignored by most archaeologist of that time and only mentioned by few (Păunescu 1999a, p. 45–46, footnote 14; Boghian 2008, p. 44; 2009, p. 120); a discussion about flint sources for the Precucuteni and Cucuteni sites (Boghian 2008, p. 44–47; 2009, p. 120–122) based only on geological and archaeological references, coherently presenting different types of flint used in these sites and the areas where these siliceous materials outcrop (Prut flint/Dniester flint or Prut-Dniester flint, Volhyno-Podolian flint, Balkan flint); O. N. Crandell analyzed and compared samples of lithic raw materials from geological sources in Eastern Carpathians, Middle Prut Valley, and Dobrogea with those from Neolithic sites in Târgu Neamț area (Crandell 2012, p. 147–158) and from UP sites in the Ceahlău Basin (Crandell *et alii* 2013), by means of mineralogical-orientated thin sections analysis, outbalanced by macroscopic features and mostly outdated and uncritically integrated geological information available for the rocks analyzed, leading straight forward to a facile provenance area for those materials.

The lack of systematic raw material sourcing surveys and petrographic investigation represents a general trait of the prehistoric archaeology in Romania. This research paucity has never been covered properly, but one should note the efforts of some of the archaeologists to integrate geological information on rock types fitted for prehistoric knapping in some kind of syntheses about possible raw material sources from Moldavia and other regions of Romania (Păunescu 1970, p. 83–89; 1996–1998, p. 83–91; 1998, p. 50–61; 1999a, p. 45–48; 1999b, p. 38–43; 2000, p. 52–57; 2001, p. 64–78; Cârciumaru *et alii* 2007c, p. 9–40; 2007d, p. 13–48).

The synthesizing effort of Al. Păunescu (1998, p. 50–61) for the Moldavia region translates into an amalgamated geological information about rocks suitable for knapping, arranged in a geographical manner, thus resulting "micro-zones" with "natural deposits of raw materials" that could be considered as possible supply sources for the prehistoric people. However complete and exhaustive was the information incorporated in this synthesis, the terminology employed was taken as used by the cited authors and not discussed, thus bringing into archaeological literature uncontrolled, outdated and conflicting terms for chert or other rock types.

After almost a decade and a little bit late, the same geological information on natural deposits of siliceous rocks in Romania was packed in a new wrapping (Cârciumaru *et alii* 2007c, p. 7–40; 2007d, p. 13–48) and served "undigested" to the archaeologists, as if the only problem of lithic raw material studies at that time was the lack of comprehensive and amalgamating papers on possible prehistoric supply sources. After correcting Păunescu's citation mistakes regarding siliceous rocks from the geological literature (Cârciumaru *et alii* 2007c, p. 8–9), the information was grouped based on the siliceous types names (such as flint, radiolarite, jasper, chaille, lidite, chert, menilite and menilitic schist, obsidian), but gave no real discussion about the importance and impact of these raw material sources for the prehistoric people (also a shortcoming that these authors criticized about Păunescu's overview). More important, the terminology of siliceous rocks from the geological literature was not discussed and harmonized, perpetuating the conflicting and obsolete chert terminology. For example, geological information compiled under flint[1] contains references to black flint beds ("silexuri negre, groase de până la 10 cm"), flint beds with variously colored bands (opalescent striped holsteins), menilitic flints ("silexuri menilitice"), thin flint lenses in Doamna Beds (also described later in the category of *chaille*), beds and banks of red, green and black flints around Lepşa creek (Cârciumaru *et alii* 2007c, p. 11–12). All of these citations most certainly refer to different types of cherts (most of them bedded), but they were erroneously joined together under the term "flint".

Given this petroarchaeological framework, or the lack of it, the current study presents the petrographic analysis of raw material samples from Lespezi-Lutărie site (Lower Bistrița Valley). This analysis is based on a research methodology orientated towards detailed microscopic characterization (sedimentological, mineralogical, micropaleontological) integrated in the regional geological framework, which enables more explicit classifications and a base for raw material comparisons between prehistoric sites and sources.

[1] Note that flint is understood by M. Cârciumaru as a nodular or lenticular siliceous accident in limestones or clays, grouped under nodular cherts together with chaille and nectic chert (Cârciumaru 2000, p. 7–9).

ARCHAEOLOGICAL AND GEOLOGICAL CONTEXT

Lespezi-Lutărie site is located near the village of Lespezi (Gârleni commune, Bacău County, Romania), on the right side of Lower Bistriţa Valley (Pl. 1). From Piatra Neamţ to Buhuşi towards South-East and South, Bistriţa River runs through Cracău-Bistriţa Depression (200–500 m absolute altitude). This depression is outlined by Moldavian Plateau's westward extension, Runcu Hill (515 m absolute altitude), and Pietricica Bacăului Ridge (600–650 m absolute altitude) (see Oncescu 1965, p. 152; Tufescu 1966, p. 94–96, 105; Dumitrescu *et alii* 1970, p. 19; Roşu 1973, p. 297–302).

The area where the site is located corresponds to the contact area between the Moldavian Platform and the Subcarpathian Nappe (15–20 km wide). The latter is composed of Miocene molasse deposits, folded and thrust over the undeformed foreland (Eastern European Platform), but also alluvial terrace deposits formed by the Bistriţa and its tributaries (Joja *et alii* 1968a, p. 11; Dumitrescu *et alii* 1970, p. 20; Mutihac *et alii* 2007, p. 123–124; Maţenco, Bertotti 2000, p. 263). None of these deposits bear any of the rock types mentioned above, which are to be found further to the West, in Tarcău and Vrancea nappes, composed of Cretaceous and Paleogene flysch-type deposits (Pl. 1, Table 1).

The archaeological excavations of Lespezi-Lutărie site (1962–1965, 1967–1968), coordinated by Maria Bitiri and Viorel Căpitanu (Bitiri, Căpitanu 1972, p. 39–68; Bitiri-Ciortescu *et alii* 1989, p. 12–21; Păunescu 1998, p. 298) revealed six archaeological layers, a total number of 8330 lithic pieces and lots of animal bone fragments scattered across the excavated surface (levels VI, V and I) or concentrated around hearths (levels IV, III and II). Level IV was identified in the lower part of the clayey-sandy yellow deposit D-b, at 3.7–3.2 m deep (Bitiri-Ciortescu *et alii* 1989, 15). In level IV were uncovered many surface hearths, unevenly spaced, and well outlined patches of red burned earth (8 to 20 cm thick) with ash and charcoal. Small knapping workshops composed of sandstone pebbles and blades and flakes of the same rock were found in proximity of the surface hearths. There were also found well individualized hearths with cavities filled up with ash, bone and wood charcoal, lithic debris, stone tools and faunal remains, and various materials spread around them (2–5 m^2). One such hearth had a concentration of materials around it (0.5 m wide) counting 500 lithic debris items, blades, flakes, cores and tools. Not far from this hearth was a concentration of broken bones with two large sandstone pebbles (2–3 kg each) and a smaller one.

The findings were assigned to different stages of the Gravettian techno-complex (Upper Palaeolithic) from the Bistriţa Valley, based on lithic typology/technology and three uncalibrated radiocarbon dates (18070±350, 18160±300 and 17670±320 BP) obtained on samples collected from hearths in levels III and II (Bitiri, Căpitanu 1972, p. 66; Bitiri-Ciortescu *et alii* 1989, p. 9–10; Păunescu 1998, p. 306, 309). For a full re-evaluated interpretation of the lithic material from the Lespezi-Lutărie site the readers are referred to Păunescu (1998, p. 298–314), while for more recent overviews on the geo-archaeological and chronological context of UP sites from Bistriţa Valley see Niţă (2008), Steguweit *et alii* (2009), Cârciumaru *et alii* (2010b).

MATERIALS AND METHODS

The present petrographic analysis was conducted as part of a recent archaeological research at Buda-Dealu Viilor and Lespezi-Lutărie sites (Dobrescu *et alii* 2013a, p. 30; 2013b, p. 85–86; 2014a, p. 32–33; 2014b, p. 81–82), which also included four field surveys in the area surrounding the sites (the data and the samples collected are still under analysis and thus the results will not be presented in this article). This analysis includes a visual evaluation of the lithic assemblage from layer IV of the Lespezi site (excavations of M. Bitiri and V. Căpitanu – T I/1964, SIII/1964, S VI/1967), followed by macroscopic and microscopic detailed investigations.

The macroscopic examination of the archaeological hand specimens had a two-fold aim: the external appearance (color and consistency of cortex, naked eye visible fossils) and the 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). Macroscopic examination allowed the separation of broad categories and varieties within each of these. This variability was covered by 20 thin sections, while some rarely encountered ones were left out in this phase.

Microscopic analysis was conducted on 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 photomicrograph camera (Wide Field 10× and digital zoom of 3×).

West	Eastern Carpathians Outer Flysch							East
Series	**Tarcău Nappe**							**Marginal Folds (Vrancea) Nappe, Bistrița half-window**
Miocene	**Fusaru Lithofacies**	Vinețișu Fm		**Moldovița Lithofacies**	Vinețișu Fm	**Kliwa Lithofacies**		Gura Șoimului Fm (polygenic breccias)
		Fusaru Fm (micaceous litharenites)	Pelitic-arenitic Mb		Moldovița Fm (bituminous shales and micaceous litharenites/ quartzarenites)		Kliwa Fm (quartz-arenites)	Upper Dysodilic Shales and Menilites Fm (laminated black shales, siltites, quartzarenites, sub-arkoses, bentonitic clay beds)
			Dysodilic Shales Mb					
			Arenitic Mb					
Oligocene (Pg3)		Lower Dysodilic Shales Fm			Lower Dysodilic Shales Fm		Lower Dysodilic Shales Fm with Kliwa Sst (shales with quartzarenites)	
		Bituminous Marls Fm			Bituminous Marls Fm		Bituminous Marls Fm (laminated bituminous marls, **chert beds and lenses**, quartzarenites, marls)	
		Lower Menilites Fm			**Lower Menilites Fm**		**Lower Menilites Fm**	Compact Menilites Mb (**silicified shales, black chert beds**)
								Lingurești Brown Marls Mb (black shales, Fierăstrău quartzarenites, brownish marls, **black chert**)
Eocene (Pg2)	**Tarcău Lithofacies**	Ardeluța Fm		**Tazlău Lithofacies**	Lupoaia Sandstones Fm	**Doamna Lithofacies**	Lucăcești Sandstones Fm (quartzarenites)	
		Podu Secu Fm			Plopu Fm		Bisericani Fm	Globigerina marls Mb
								Greenish-gray mudstone Mb
								Green and red shales Mb
		Tarcău Sandstones Fm (massive litho-feldspathic arenite with conglomerates)			Tazlău Fm (Tarcău Sst with limestone)		**Doamna Limestone Fm** (whitish bedded micrite limestones with *chaille*-type **chert nodules and lenses**, calcarenites, marls)	
							Sucevița Fm	Jgheabu Mare Fm (bluish spongolithic limestones, bluish shales)
Paleocene (Pg1)					Straja Fm (fine turbidites with spiculite)		Straja Fm	Piatra Uscată Fm (grayish-greenish silty shales, calcarenites, arenites)
		Horgazu Fm (sandy-marly flysch)			Izvoru Fm		Izvoru Fm	Putna Fm (grayish clays, arenites, calcarenites, limestones, polygenic breccias)
Upper Cretaceous (K2)				Hangu Fm (mainly marls)				**Lepșa Fm** (gray sandy marls, olistostrome of black shale with **black chert**)
Lower Cretaceous (K1)	Cârnu-Șiclău/Lupchianu Fm (variegated shale with calcareous sandstones intercalations)							
	Audia Fm	Upper Mb (glauconitic arenites and graywackes interbedded with black and grey shales)					**Sărata Fm**	Upper Mb (sandy marls, marls, polygenic breccias, calcarenites)
		Middle Mb (black and grey shales, calcareous sandstones, spongolitic sandstones, **siliceous shales**, **lidite/black nodular cherts**, and breccias with granodiorites fragments)						Middle Mb (**silicified black shales**, **black chert beds**, stratified calcarenites, breccias)
		Lower Mb (black and grey shales with rare intercalations of calcareous sandstones and rather frequent beds or lenses of spherosiderites)						Lower Mb (black shales with turbiditic arenites, conglomerates, slumps)

Table 1. Lithostratigraphy of Romanian Eastern Carpathian Flysch (Tarcău and Vrancea nappes)*. Fm – Formation; Mb – Member; Sst - Sandstones.
* Geological information compiled after Gigliuto *et alii* (2004), Puglisi *et alii* (2006), Miclăuş *et alii* (2009), Belayouni *et alii* (2009), Roban, Melinte-Dobrinescu (2012), Amadori *et alii* (2012), Guerrera *et alii* (2012).

Reference	Raw-material	Characteristics	Origin
Păunescu 1998, p. 48–49 Păunescu 1970, p. 219	black schist	black color, mudstone texture, compact, conchoidal fracture, very hard; groundmass composed of "mixed terrigenous minerals (clay), cryptocrystalline and detritic quartz, intensely brown-chocolate colored"	Audia Beds (Eastern Carpathians Flysch)
Roban, Melinte-Dobrinescu 2012, p. 55–56	shaly lithofacies	clay minerals, silt and clay sized terrigenous material (quartz and micas), bioclastic carbonate (foraminifera, echinoderms, bivalves and carbonate material), sponge spicules	Audia Fm, Tarcău Nappe
Puglisi *et alii* 2006, p. 114–115	menilite	organic siliceous rock with a high fossil content (diatoms, sponges and rare radiolarians)	the Southern sectors of the "menilite facies"
		chemical siliceous rock devoid of fossils	the Northern outcrops of the "menilite facies"
Păunescu 1998, p. 48–49	menilite	compact and hard, brown or blackish color, evenly striped; opal with pigments or linear accumulations of bitumen (opaque), silt-sized angular quartz clasts and muscovite flakes, radiolarians, sponge spicules, sporadic glauconite	Eastern Carpathians Flysch
Puglisi *et alii* 2006, p. 114–115	bedded cherts	brownish thin-bedded strata composed of chalcedony, crypto- and/or microcrystalline quartz, lacking fossils and passed through intense diagenesis, devoid of clay minerals	the "menilite facies" of Lower Menilites Fm, Moldovița Lithofacies
Amadori *et alii* 2012, p. 1604 and 1612	siliceous rocks	microcrystalline quartz background (90-92%) with a rectangular system of fractures filled with neomorphic calcite (8-10%), without extrabasinal supply	Lower Menilites Mb, Vrancea Nappe
Cârciumaru *et alii* 2006, p. 323; Steguweit 2009, p. 34	menilith	black or dark-brown siliceous rock characterized by a rhythmic lamination, due to the alternation between opal and organic (chalcedony) sequences	Eastern Carpathians Flysch
Păunescu 1998, p. 48	glauconitic siliceous	greenish color, arenite texture; composed of quartz grains bounded by siliceous cement, with glauconite grains in amount over 5%	Eastern Carpathians Flysch
Păunescu 1970, p. 223–224	sandstone	gray-brownish color, fine-grained, aleuritic-psamitic texture; predominantly composed of detrital quartz, feldspars, clay minerals, glauconite (around or above 5%) and amorphous and cryptocrystalline quartz as basal cement	
Miclăuş *et alii* 2009, p. 411–413	Fierăstrău and Lucăceşti Sst	predominantly quartz, low amounts of feldspars and lithoclasts, high content of glauconite (average content about 7.9%) and very low content of carbonate	Lingureşti Marls Mb and Lucăceşti Sst Fm, Vrancea Nappe
Amadori *et alii* 2012, p. 1607	quartzarenites	well-sorted monocrystalline quartz (average size 250 µm), plagioclase, K-feldspars, opaque minerals, chert, muscovite flakes glauconite, green schist lithic grains	Bituminous Marl Mb, Dysodilic Shales Mb, Vrancea Nappe
Roban, Melinte-Dobrinescu 2012, p. 58-61	quartzarenites	predominantly detrital quartz, glauconite averaging around 3% (but higher percentages do occur), carbonate cement around 10% with subordinate siliceous cement	Audia Fm, Tarcău Nappe
	quartzarenites with carbonate bioclasts	predominantly detrital quartz, carbonate bioclasts around 10% (fragments of echinoderm, bivalves, calcified or partially dissolved siliceous sponges spicules), low quantity of glauconite (under 1%) and a high quantity of carbonate cement (15-20%)	
Roban, Melinte-Dobrinescu 2012, p. 6	calcarenites	carbonate bioclasts (echinoderms, bryozoans, red algae, bivalves and foraminifer fragments), terrigenous admixtures not exceeding 20% (monocrystalline and polycrystalline quartz, metamorphic lithic fragments, sedimentary lithoclasts of shales), siliceous spicules, carbonate sparite cement with overgrowth structure on echinoderms	Audia Fm, Tarcău Nappe
Amadori *et alii* 2012, p. 1605	calcarenites	matrix-supported, poorly sorted, composed of quartz, metamorphic lithic fragments, opaque minerals, and bioclasts (algae, sponge spicules, echinoderms, benthic foraminifera), with intergranular material either as carbonated matrix or sparitic cement	Sărata Fm, Putna Fm, Jgheabu Mare Fm, Vrancea Nappe

Table 2. Characteristics and nomenclature of rock types from Eastern Carpathian Flysch.

In the microscopic characterization of Lespezi-Lutărie raw-materials, I have applied the microfacies concepts of carbonate rocks (Wilson 1975; Flügel 1982, 2010) to cherts and systematic petrography of siliciclastic rocks to shale and sandstones (Pettijohn *et alii* 1972; Potter *et alii* 1980; Potter *et alii* 2005; Boggs 2009). Thus, special attention was 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. For all samples analyzed, traits indicating the diagenetic fabric were described through cumulative observations regarding dissolution, compaction (grain contacts), cementation (type and mineralogy of cements), and neomorphism (silicification). Depositional fabric for each thin section was inferred from the estimated amount of particles, matrix, cement, and also grain-support type and packing. The recorded mineralogy of each grain type, cement and matrix represents the basis for estimated mineralogical composition in individual thin sections.

The present study does not beneficiate of comparative samples from geological sources (primary or secondary), but for some of the samples it has been possible to determine the geological age (based manly on microfauna identified in thin sections), while the available geological and petro-archaeological information was used to determine their geological occurrence and possible provenance (Tables 1 and 2).

PETROGRAPHY AND GEOLOGICAL OCCURRENCE OF LESPEZI-LUTĂRIE RAW MATERIALS

Visual evaluation of Lespezi-Lutărie samples (level IV) allowed 5 categories of raw materials to be established based on macroscopic features (Table 3): 1) sandstones, samples Le-Lu [01]-[05], [28] (Pl. 2); 2) black shales, samples Le-Lu [06]-[08] (Pl. 2); 3) menilite, samples Le-Lu [09] and Le-Lu [11] (Pl. 3); 4) brownish-gray cherts[2], samples Le-Lu [10], [12]-[14] (Pl. 3); 5) nodular cherts from chalk and chalk-like deposits, samples Le-Lu [15]-[27], [30]-[31], [40] (Pl. 4–6). Alteration surfaces hampered a proper evaluation for some of the pieces examined, such samples (Le-Lu [32]-[39]) being classified as unidentifiable cherts (Pl. 6).

The examination of flakes from the early stages of reduction sequences show external characteristics grading from “fresh cortex” to thin remnant cortical surfaces typical for clasts carried on shorter distances from the primary deposits (this is the case of most nodular cherts and gray-brownish chert, Pl. 3–5). Other samples present rounded corners and new cortical surfaces (neo-cortex) typical of clasts carried long enough to be shaped and rounded by water (this is the case for the black shale, sandstones, and some of the nodular cherts, Pl. 2, 4–5). These features indicate that the probable supply sources were alluvial deposits, a fact already acknowledged both for local raw materials and those from distant sources by previous research of UP sites from Bistrița Valley.

Using the microfacies criteria mentioned in the previous section, 16 raw material varieties were characterized, broadly pertaining to the above mentioned categories. Microscope analysis validated most of the varieties determined macroscopically, but in some cases proved that visual similarities are misleading. In the following lines, a short description of these varieties will be given, while main characteristics are to be found in Tables 3–6, Figures 1–4, and in texts of Plates 7 to 15.

The macroscopic varieties included in the “sandstones” category, were identified as follows: detrital-rich spiculite chert (variety [01a], Le-Lu [01], Pl. 7) predominantly composed of fine sand-sized particles giving it a coarser macroscopic aspect, material that might correspond to what C. Papacostea described as spongolithic chert (Păunescu 1970, p. 218); bioclastic packstone (variety [01b], sample Le-Lu [02], Pl. 7) composed of fine sand-sized particles, mainly bioclasts and subordinate detrital quartz (calcarenite); two types of quartzarenites represented by samples Le-Lu [03]/Le-Lu [05] (variety [01c], Pl. 8) and Le-Lu [04] (variety [01d] Pl. 8), differentiated at the level of cement mineralogy and fabric (Table 5) and through bioclastic content (see Fig. 1), both containing about 5% glauconite. Variety [01d] corresponds broadly to what is known in archaeological and older geological literature as glauconitic siliceous sandstone (Table 2). In all of these samples microfauna (Fig. 3) is fragmentary and unusable for geological stage/period determination. First attempt to determine the provenance of this raw material was done by Th. Joja, who considered the glauconitic siliceous sandstone as derived from the Middle Cretaceous deposits of Audia Beds (Nicolăescu-Plopşor *et alii* 1966, p. 20,

[2] In this study, *chert* is understood as encompassing all sedimentary siliceous rocks of chemical, biochemical or biogenic origin.

note 17), found in the natural openings at Hangu, near Răpciuni Basin. Calcarenites and quartzarenites are characteristic rock types of many deposits in this area (see Table 2; Gigliuto *et alii* 2004, p. 305–307; Puglisi *et alii* 2006, p. 112–114) and without specimens from geological deposits, it is impossible to relate samples from this study to any particular geological formation and/or member.

In the "black shale" category, the microscopic analysis revealed that sample Le-Lu [06] (variety [02a]) is actually a blackish peloidal chert (Pl. 12), while the other two samples represent a black shale (Le-Lu [07], variety [02b], Pl. 9) and a carbonate shale (Le-Lu [08], variety [02c], Pl. 9). The carbonate shale exhibits petrographic characteristics (secondary recrystallization of carbonates) also described by Roban, Melinte-Dobrinescu (2012, p. 56) for the carbonaceous shale of Audia Fm (Tarcău Nappe) and is not mentioned anywhere else. Variety [02b] might correspond to what archaeologist in this area call Audia black schist (see Table 2), belonging to the Lower Cretaceous of Audia Beds (Nicolăescu-Plopşor *et alii* 1966, p. 20, note 17). Sample Le-Lu [07] contains some planktonic foraminifera, but was not possible to assign them to a specific family or genus (Pl. 16). Based on comparison with characteristics of black shale from Audia Fm (see Table 2), variety [02b] it may be identified as Audia black schist, but it should be noted that black shale is one of the most common lithologies in the Eastern Carpathian Flysch (Tables 1 and 2).

I have identified as menilite (variety [03]) a material regularly striped and composed of alternating laminae of silicified quartzarenite and detrital-rich bioclastic wackestone (Pl. 10), silicified in sample Le-Lu [09] and poorly silicified in Le-Lu [11]. In sample Le-Lu [09] appears a specimen of genus *Nummulites* Lamarck (Pl. 10; subfamily *Numulitinidae* de Blainville, family Nummulitidae, superfamily Nummulitoidea, suborder Rotaliina), genus ranging from Middle Paleocene to Early Oligocene (BouDagher-Fadel 2008, p. 333). Menilites can be found in Tarcău and Vrancea nappes (see Table 1) in the Lower Menilites Fm (Early Oligocene) and Upper Dysodilic Shales and Menilites Fm (Miocene). At the beginning of the Palaeolithic research on Bistriţa Valley, the menilite was considered by Th. Joja as pertaining to Lower Oligocene deposits found in natural openings between Piatra Neamţ and Bicaz (Nicolăescu-Plopşor *et alii* 1966, p. 20, note 17). Miclăuş *et alii* (2009, p. 401) mention menilite beds with fine lamination as part of a facies association composed of black shales with bedded cherts and sandstones (Vrancea Nappe) and as intraclasts within the Bituminous Marls on Nechit Valley. This material has close macroscopic similarities with samples from the present study (Miclăuş *et alii* 2009, p. 401, fig. 3c). Based on the above data, the menilites used as raw materials in Lespezi-Lutărie site belong to Lower Menilites Fm. It has to be stated that the petrographic characterristics of the menilite described here differ from the characteristics of the "menilite facies" in Lower Menilites Fm from Tarcău and Vrancea nappes (see Table 2 for description and references), but also very different from the definition used by some archaeologists (Table 2). These conflicting characterizations of menilite might be explained by the existence of more then one type of such rock in the Early Oligocene Carpathian "menilite facies" (see Table 2), variability between depositional settings, but also due to loosely chert terminology used by the geologist working in this area (Gigliuto *et alii* 2004; Puglisi *et alii* 2006; Amadori *et alii* 2012; Guerrera *et alii* 2012).

Variety [04b] is one of the predominant raw materials in samples from level IV of Lespezi-Lutărie (at least this was the perception during sampling), which was identified as detrital-rich bioclastic chert (Pl. 11). Planktonic foraminifera from samples Le-Lu [12]-[14] (Pl. 16) were determined as belonging to *Morozovella* McGowran genus (family Truncorotaloididae, superfamily Truncorotaloidinoidea), ranging from Paleocene to Eocene (BouDagher-Fadel 2013, p. 151–152). Is not clear in which category this material was introduced in the previous descriptions of Lespezi-Lutărie raw-materials, but the fact that is not mentioned as a different rock type amongst others implies a probable amalgamation within the "menilite" of the archaeological literature regarding UP sites from Bistriţa Valley. This is neither a Cretaceous flint nor a menilite (see Table 2 for comparisons), though microscopic similarities exist between variety [04b] and the bioclastic wackestone laminae composing the menilite (high detrital quartz amounts, carbonate matrix replaced by cryptocrystalline quartz, bioclasts and planktonic foraminifera). This material is macroscopically and microscopically similar to a chert from Eastern Carpathians mentioned by Crandell (2012, p. 149–150,154, fig. 2.e, 155, fig. 3.c) as lenses in outcrops of Middle to Upper Jurassic and Middle Triassic limestones in Rarău area, but also near Voievodeasa village (Suceava county) in Voievodeasa river, left side tributary of Suceviţa. The geological setting of Voievodeasa River and the confluence with Sucevița corresponds to Vrancea Nappe (Gura Putnei half-window), where outcropping deposits of Paleocene-Eocene age are represented amongst others by Doamna Limestone Fm (Joja *et alii* 1968b, p. 46; Juravle *et alii* 2008, p. 152–154). Between the area where these Triassic and Jurassic limestones outcrop (Crandell 2012, p. 149–150) and the Voievodeasa river there is a distance of 40–50 km and no river to cross it. More so, in the deposits of Triassic and Jurassic age from Rarău area the only cherts mentioned are yellow, white and red jaspers (Joja *et alii* 1968b, p. 27). During the field surveys of 2013, a material very similar visually to that from Lespezi was found in the gravel deposits (5–6 m thick) exposed at the upper part of the Neogene sequence between Ruseni and Borleşti on Nechit valley (right side tributary of Bistrița, at about 20–25 km North-West from Lespezi site). Considering the age of the plantktonic foraminifera from these samples, the only "age-appropriate" deposits are the Doamna Limestone Fm (see Table 1), containing nodules and lenses of *chaille*-type chert, and outcropping together with other Eocene deposits West-ward from Nechit village and through the Vrancea Nappe (Joja *et alii* 1968a, p. 25; Juravle *et alii* 2008, p. 152–154; Guerrera *et alii* 2012, p. 466; Amadori *et alii* 2012, p. 1602–1603). The same type of planktonic foraminifera as in variety [04b] were identified in a marl bed of Doamna Limestone Fm (Vrancea Nappe), indicating the Middle Eocene and sedimentation in an outer platform setting (Guerrera *et alii* 2012, 466, 469–472). This is only an assumption until further research is carried out on samples from outcrops of these deposits.

A macroscopically similar material with the previous one is variety [04a] (Pl. 12), which is a planktonic foraminifera chert, containing foraminifera from Hedbergellidae, Heterohelicidae and Globotruncanidae families (see Pl. 16), association that implies rather an Upper Cretaceous age and sedimentation in a marine deep-water environment (Table 6). This raw material (of unknown origin) can easily be confused with the other grayish chert [04b], and is very probable that previous research included it also in the menilite category.

Samples assigned to the category of nodular cherts from chalk and chalk-like deposits (Le-Lu [15] to Le-Lu [20]) have enough macroscopic characteristics doubled by microscopic features (microfacies) to enable their separation into different varieties (Pl. 4–5): very translucent blackish Globotruncanidae chert (microfacies [05bc], sample Le-Lu [17], Pl. 13); very translucent blackish cementstone chert (microfacies [05b]; sample Le-Lu [16], Pl. 13); blackish translucent bioclastic chert (microfacies [05a], sample Le-Lu [15], Pl. 14); very translucent grayish-brown spiculite chert (microfacies [05cd], Le-Lu [19], Pl. 14); semi-translucent beige-cream bioclastic-spiculitic chert (microfacies [05c], Le-Lu [18], Pl. 15); yellowish-brown phosphatized bioclastic chert (microfacies [05d], Le-Lu [20], Pl. 15). These nodular cherts contain microfauna in a very poor preservation state due to intense silicification. In spite of this, the observed planktonic foraminifera in samples Le-Lu [15], Le-Lu [17], Le-Lu [18] and Le-Lu [20] (Pl. 16 for details) indicate that these nodular cherts were formed in Upper Cretaceous chalks (at least Late Coniacian to Maastrichtian after the Globotruncana foraminifers). Fossils association in all samples described above indicate marine deep-water environments, from deep shelf to cratonic basin (Table 6). Looking at the geological context (Table 1) we can see that the Upper Cretaceous nodular cherts are not mentioned in sedimentary suites of Tarcău and Vrancea nappes.

Comparing these samples with recent petrographic works on raw materials from the Moldavia region (Crandell 2012; Crandell *et alii* 2013), one might be tempted to consider the blackish and gray-brownish translucent cherts (samples Le-Lu [15]-[17], Le-Lu [19], Pl. 4–5, 13–15) as Moldavian flint, found in "Upper Cretaceous (Cenomanian) chalky marl throughout the Moldavian plateau between the Upper Prut and Upper Dniester rivers and as fluvial deposits south of this area" (Crandell 2012, p. 147–149, 154, fig 2.a, 155, fig. 3.a, 157, fig. 5.d–g, 158, fig. 6.c). The author mentioned above identified this siliceous material in UP sites from Middle Bistrița Valley (Bistricioara-Lutărie, Ceahlău-Dârțu), and describes it as being "devoid of anything but quartz" (Crandell *et alii* 2013, p. 39, fig. 6.a–b, fig. 7.a–f). This is in contradiction with the microfauna (carbonate bioclasts, foraminifera, radiolarians and sponge spicules) mentioned in a previous petrographic description of Middle Prut Valley flint (Muraru 1990, p. 151–152) and comparable with that from the four microfacies determined in this study. Also, the age given by Crandell (2012, p. 147) for the Moldavian flint is inaccurate and based on outdated geological data, ignoring the Campanian to Maastrichtian age determined for this material by A. Muraru (1990, p. 152, 155) and confirmed by the present analysis.

No.	Raw-material types	Sample code	Structure	Fracture	Luster	Transparency	Color
1a	detrital-rich spiculite chert	Le-Lu [01]	massive bedding	conchoidal	dull	translucent	dark gray
1b	calcarenite	Le-Lu [02]	massive bedding	conchoidal	dull	translucent	dark gray
1c	calcareous quartzarenite	Le-Lu [05], [03]	massive bedding	conchoidal	dull	semi-translucent	medium gray
1d	siliceous quartzarenite	Le-Lu [04]	massive bedding	conchoidal	dull	translucent	greenish-gray
2a	peloidal chert	Le-Lu [06]	nodular	conchoidal	greasy	translucent	very dark gray to black
2b	black shale	Le-Lu [07]	bedded	conchoidal	dull	opaque	blackish
2c	carbonate shale	Le-Lu [08]	very thinly laminated	conchoidal	dull	opaque	grayish
3	menilite	Le-Lu [09], [11]	thinly laminated	conchoidal	greasy	semi-translucent	grayish
4b	Pg2 grayish chert (Doamna Limestone Fm "chaille")	Le-Lu [12], [13], [14]	nodular/lenticular	conchoidal	greasy	semi-translucent	medium gray-brownish
4a	grayish K2 nodular chert	Le-Lu [10]	nodular	conchoidal	greasy	semi-translucent	medium gray
5a	K2 nodular chert from Middle Prut Valley	Le-Lu [15]	nodular	conchoidal	greasy	translucent	bluish dark gray
5b	(Prut flint)	Le-Lu [16]	nodular	conchoidal	greasy	very translucent	very dark gray
5bc		Le-Lu [17]	nodular	conchoidal	greasy	very translucent	clear black
5cd		Le-Lu [19]	nodular	conchoidal	greasy	very translucent	clear grayish brown
5c	bioclastic-spiculitic K2 nodular chert	Le-Lu [18]	nodular	conchoidal	dull	semi-translucent	beige-cream and gray
5d	K2 phosphatized bioclastic chert	Le-Lu [20]	nodular	conchoidal	greasy	semi-translucent	yellowish-brown

Table 3. Macroscopic characteristics of raw material types from Lespezi-Lutărie site.

No.	Microfacies	Support	Depositional fabric	Sorting	Grain size	Diagenetic fabric
1a	detrital-rich radiolaria bearing spiculite chert	grain-supported	packstone	moderate	very fine to fine sand	siliceous siliciclastic-bioclastic packstone
	silicified quartz graywacke	matrix-supported	wackestone	moderate	very fine to fine sand	siliceous quartz graywacke
1b	silicified detrital-rich bioclastic packstone	grain-supported	packstone	moderate	very fine to fine sand	poorly silicified echinoderm-shell packstone
1c	glauconitic calcareous quartz arenite	grain-supported	packstone	moderate	fine sand	poorly silicified calcareous quartz arenite
1d	glauconitic silicified quartz arenite	grain-supported	packstone	moderate	fine to medium sand	siliceous quartz arenite
2a	peloidal packstone chert	grain-supported	packstone	moderate	very fine sand	siliceous peloidal packstone
2b	silicified black clay shale	matrix-supported	mudstone	moderate	medium to coarse silt	poorly silicified claystone
2c	silicified micrite	matrix-supported	mudstone	well	fine to coarse silt	siliceous cementstone
	silicified calcareous wackestone	matrix-supported	wackestone	well	fine to coarse silt	bioclastic siliceous cementstone
3	bioclastic wackestone chert	matrix-supported	wackestone	moderate	very fine to fine sand	bioclastic siliceous cementstone
	bioclastic wackestone	matrix-supported	wackestone	moderate	very fine to fine sand	very poorly silicified bioclastic wackestone
	silicified quartz arenite	grain-supported	packstone	well	fine sand	silicified quartz arenite
4b	detrital-rich bioclastic chert	matrix-supported	wackestone	moderate	very fine to fine sand	quartz-bioclastic siliceous cementstone
4a	planktonic foraminifera chert	matrix-supported	wackestone	moderate	very fine sand	planktonic foraminifera siliceous cementstone
5a	bioclastic chert	matrix-supported	wackestone	moderate	very fine sand	bioclastic-peloidal siliceous cementstone
5b	cementstone chert	matrix-supported	mudstone	moderate	very fine sand	siliceous cementstone
5bc	Globotruncanidae chert	matrix-supported	wackestone	moderate	fine sand	planktonic foraminifera siliceous cementstone
5cd	spiculite chert	matrix-supported	wackestone	well	fine sand	bioclastic siliceous cementstone
5c	bioclastic-spiculitic chert	matrix-supported	wackestone	moderate	very fine sand	bioclastic siliceous cementstone
	cementstone chert	matrix-supported	mudstone	moderate	coarse silt to very fine sand	siliceous cementstone
5d	phosphatized bioclastic chert	matrix-supported	wackestone	moderate	very fine sand	phosphatized bioclasts siliceous cementstone

Table 4. Texture and fabric of microfacies recognized in raw material types from Lespezi-Lutărie site.

No.	Microfacies	Groundmass**	Matrix		Cement	InterPartCem		FracCem		SyntCem		Replacement Cement		Recrystallized Cement	
1a	detrital-rich radiolaria bearing spiculite chert	23.8	micrite	1.0	22.8	Qf-By	16.8	-	0.0	Cal	1.0	Qcc	5.0	-	0.0
	silicified quartz graywacke	42.5	micrite	2.0	40.5	-	0.0	-	0.0	Cal	0.5	Qcc	40.0	-	0.0
1b	silicified detrital-rich bioclastic packstone	31.0	calcisiltite	2.0	29.0	-	0.0	-	0.0	Cal	10.0	Qcc	19.0	-	0.0
1c	glauconitic calcareous quartz arenite	20.0	mud*	2.0	18.0	Spar	10.0	-	0.0	-	0.0	Qcc	8.0	-	0.0
1d	glauconitic silicified quartz arenite	18.0	mud*	2.0	16.0	-	0.0	-	0.0	-	0.0	Qcc	16.0	-	0.0
2a	peloidal packstone chert	39.5	micrite	3.0	36.5	Qf-By	20.0	-	0.0	Cal	10.0	Qcc	6.5	-	0.0
2b	silicified black clay shale	78.3	mud	60.0	18.3	-	0.0	-	0.0	-	0.0	Qcc	18.3	-	0.0
2c	silicified micrite	93.2	micrite	5.0	88.2	-	0.0	-	0.0	-	0.0	Qcc	86.2	Cal-Ine-Idio	2.0
2c	silicified calcareous wackestone	60.0	micrite	10.0	50.0	-	0.0	-	0.0	-	0.0	Qcc	40.0	Cal-Ine-Idio	10.0
3	bioclastic wackestone chert	76.5	micrite	15.0	61.5	-	0.0	-	0.0	Cal	0.5	Qcc	61.0	-	0.0
	bioclastic wackestone	64.8	micrite	60.8	4.0	-	0.0	-	0.0	-	0.0	Qcc	4.0	-	0.0
	silicified quartz arenite	26.9	mud	2.0	24.9	Qf-By	23.4	-	0.0	Cal	1.5	-	0.0	-	0.0
4b	detrital-rich bioclastic chert	78.1	micrite	15.0	63.1	-	0.0	-	0.0	-	0.0	Qcc	63.1	-	0.0
4a	planktonic foraminifera chert	72.9	micrite	10.0	62.9	-	0.0	-	0.0	Sil	0.5	Qcc	62.4	-	0.0
5a	bioclastic chert	83.3	micrite	5.0	78.3	-	0.0	Qf-By	2	-	0.0	Qcc	76.3	-	0.0
5b	cementstone chert	94.0	micrite	2.5	91.5	-	0.0	-	0.0	-	0.0	Qcc	91.5	-	0.0
5bc	Globotruncanidae chert	69.5	micrite	2.0	67.5	-	0.0	-	0.0	-	0.0	Qcc	67.5	-	0.0
5cd	spiculite chert	81.2	micrite	2.5	78.7	-	0.0	-	0.0	-	0.0	Qcc	78.7	-	0.0
5c	bioclastic-spiculitic chert	64.9	micrite	10.0	54.9	-	0.0	-	0.0	-	0.0	Qcc	54.9	-	0.0
	cementstone chert	89.8	micrite	2.5	87.3	-	0.0	-	0.0	-	0.0	Qcc	87.3	-	0.0
5d	phosphatized bioclastic chert	64.0	micrite	5.0	59.0	-	0.0	-	0.0	-	0.0	Qcc	59.0	-	0.0

Table 5. Groundmass composition of microfacies recognized in raw material types from Lespezi-Lutărie site.

Groundmass – the combined amount of matrix and cement;
Matrix – interstitial material mechanically deposited between larger grains (Flügel 2010, p. 73); micrite – the fine-grained matrix (1–4 μm) of carbonate rocks and the fine-grained constituent of carbonate grains (Flügel 2010, p. 75); calcisiltite – fine-grained matrix (2–62 μm) composed of detrital silt-sized calcite particles (Flügel 2010, p. 74); mud – mixture of clay and silt sized material (4–62 μm) mechanically deposited (Folk 1980, p. 25; Potter *et alii* 2005, p. 251);
* matrix of sandstones is composed of mechanically deposited particles (<30 μm) of different mineralogical nature (Pettijohn *et alii* 1972, p. 88, 158);
InterPartCem – interparticle cement; FracCem – fracture cement; SyntCem – syntaxial overgrowth cement;
Qf-By – botryoidal chalcedony cement; Spar – sparitic calcite cement; Cal – syntaxial calcite overgrowth cement; Sil – syntaxial siliceous overgrowth cement; Qcc – granular cryptocrystalline quartz cement; Cal-Ine-Idio – inequigranular idiotopic calcite cement.
** The numbers in the table represent percent values.

No.	Raw material types	Microfacies	Facies Zone	Depositional setting	Marine environment	Age
1a	detrital-rich spiculite chert	detrital-rich radiolaria bearing spiculite chert	FZ 1	cratonic basin	deep-water	-
		siliceous quartz graywacke	FZ 3	toe-of-slope	deep-water	
2b	black shale	silicified black clay shale	FZ 1	cratonic basin	deep-water	K1
2c	carbonate shale	silicified micrite	FZ 1	cratonic basin	deep-water	K1
		silicified calcareous wackestone	FZ 1	cratonic basin	deep-water	
4a	grayish K2 nodular chert	planktonic foraminifera chert	FZ 1	cratonic basin	deep-water	K2
5bc	K2 nodular chert from Middle Prut Valley	Globotruncanidae chert	FZ 1	cratonic basin	deep-water	K2
5a	(Prut flint)	bioclastic chert	FZ 2	deep shelf	deep-water	
5b		cementstone chert	FZ 2	deep shelf	deep-water	
5cd		spiculite chert	FZ 2	deep shelf	deep-water	
5c	bioclastic-spiculitic K2 nodular chert	bioclastic-spiculitic chert	FZ 2	deep shelf	deep-water	K2
		cementstone chert	FZ 2	deep shelf	deep-water	
5d	K2 phosphatized bioclastic chert	phosphatized bioclastic chert	FZ 2	deep shelf	deep-water	K2
4b	Pg2 grayish chert (Doamna Limestone Fm "chaille")	detrital-rich bioclastic chert	FZ 2	deep shelf	deep-water	Pg2
2a	peloidal chert	peloidal packstone chert	FZ 2	deep shelf	deep-water	-
1b	calcarenite	silicified detrital-rich bioclastic packstone	FZ 3	toe-of-slope	deep-water	-
3	menilite	bioclastic wackestone	FZ 3	toe-of-slope	deep-water	Pg3
		silicified quartz arenite	FZ 3	toe-of-slope	deep-water	
1c	calcareous quartzarenite	glauconitic calcareous quartz arenite	FZ 3	toe-of-slope	deep-water	-
1d	siliceous quartzarenite	glauconitic silicified quartz arenite	FZ 3	toe-of-slope	deep-water	-

Table 6. Depositional settings and age of microfacies recognized in raw material types from Lespezi-Lutărie site.

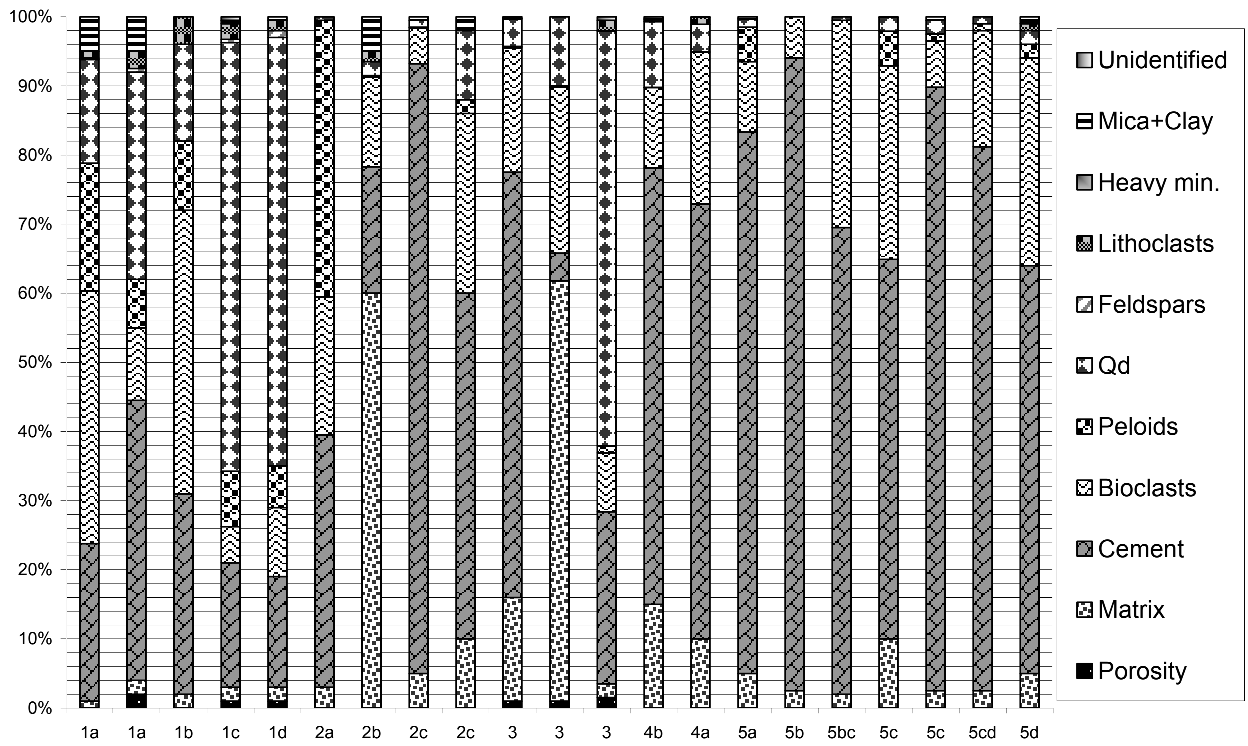


Fig. 1. Primary constituents of microfacies recognized
in raw materials from Lespezi-Lutărie site.

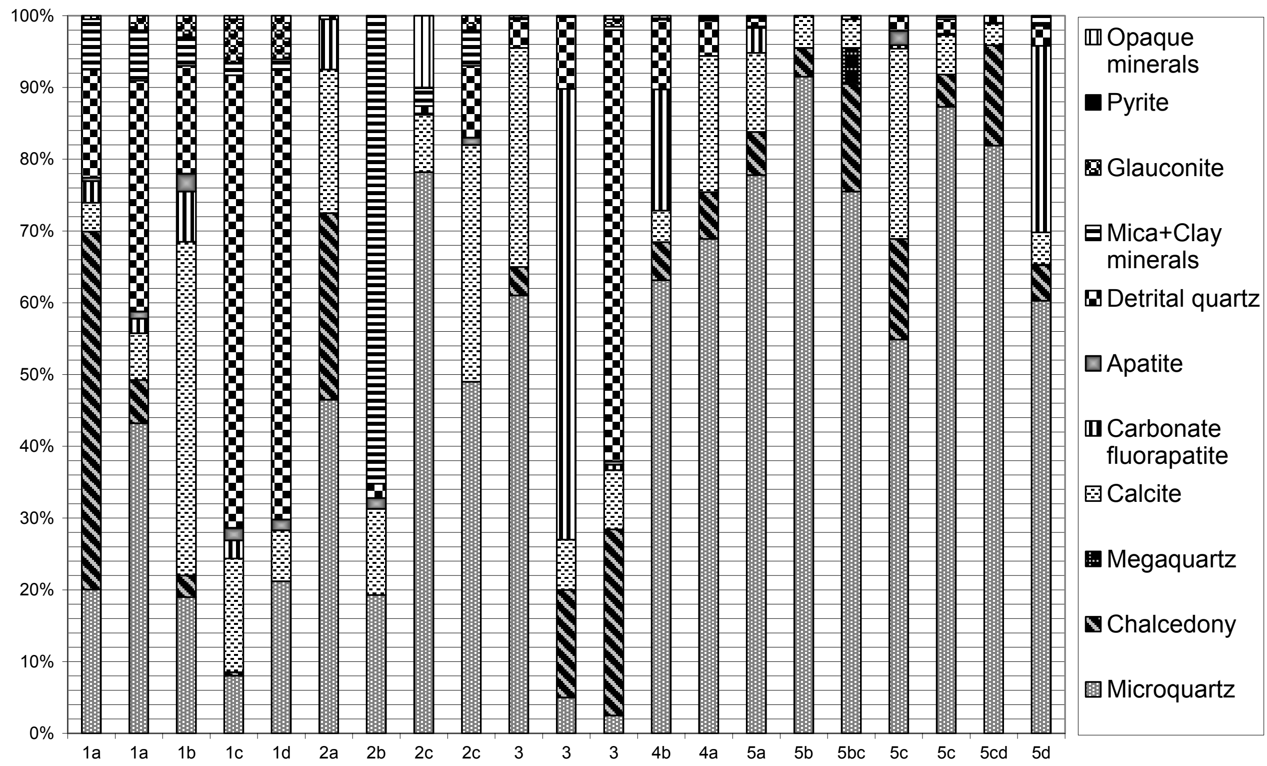
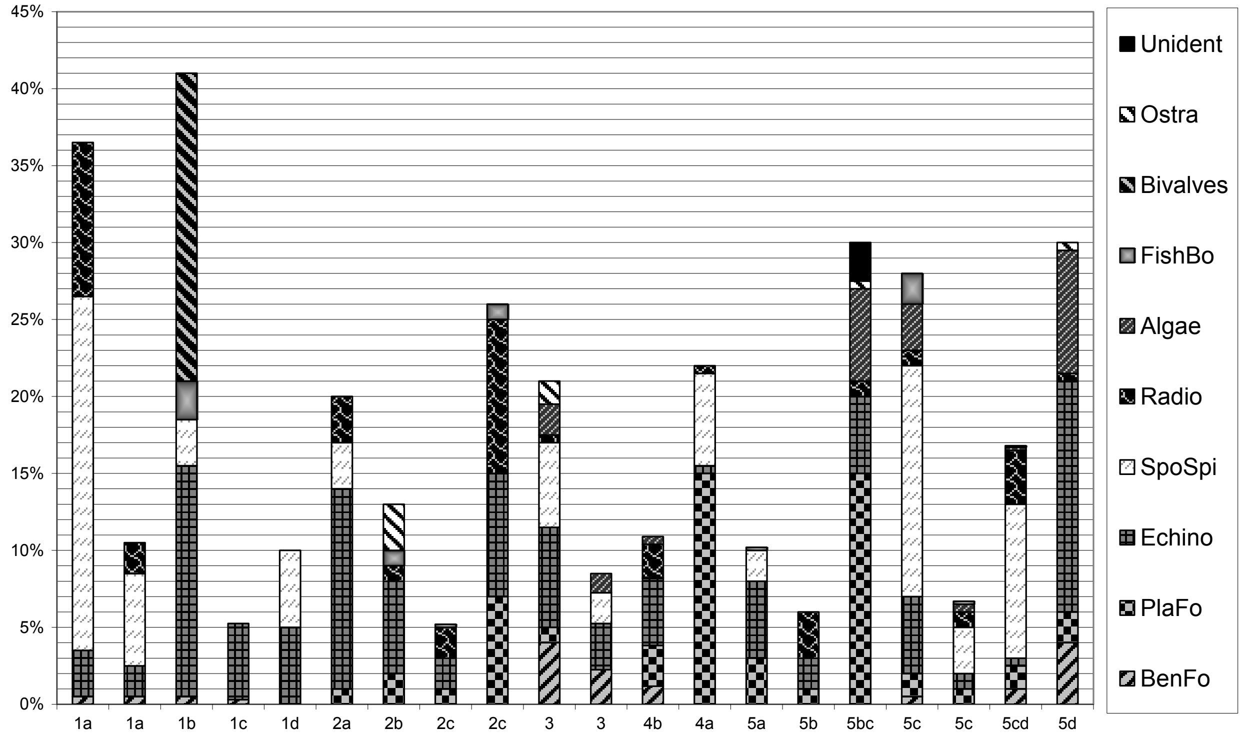
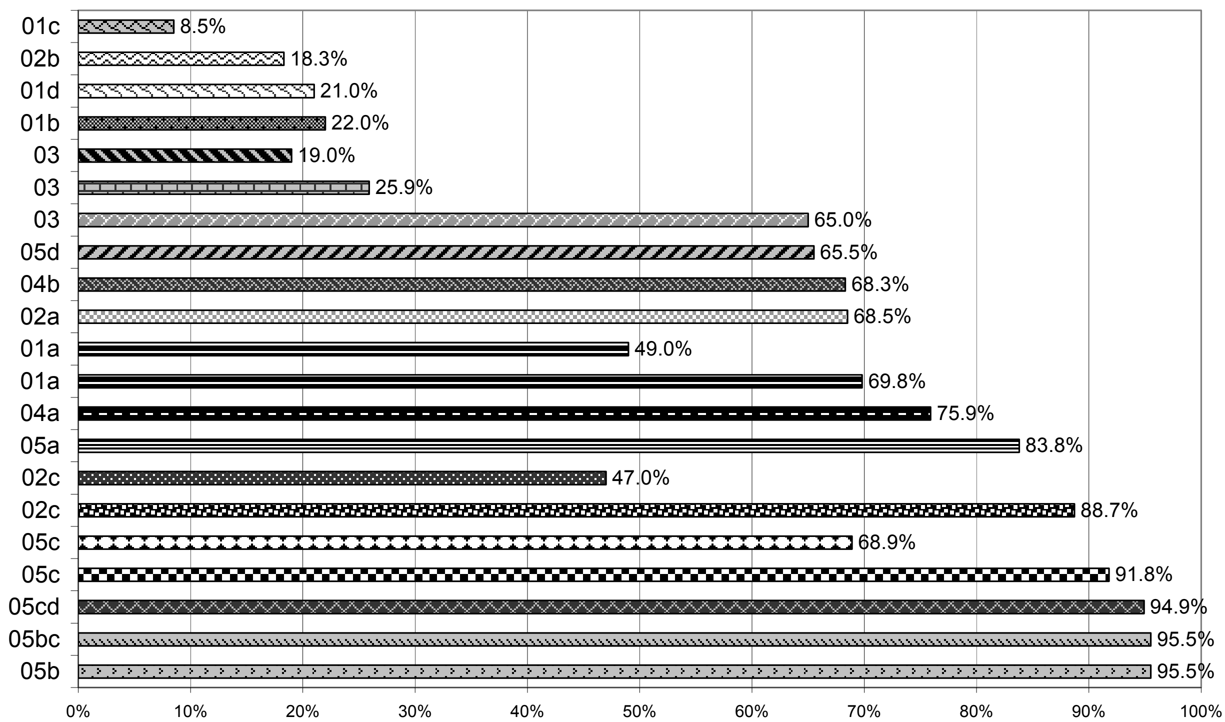


Fig. 2. Mineralogy of microfacies recognized
in raw materials from Lespezi-Lutărie site.



* Legend: Unident – Unidentified; 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.

Fig. 3. Petrographic fossil distribution of microfacies recognized in raw materials from Lespezi-Lutărie site*.



* Using the recorded mineralogy of grains, the silicification intensity was determined by summing up the percentage of siliceous particles and the percentage of siliceous cement in each thin section. Thus, five stages of silicification intensity were established: **very strong** (above 80%), **strong** (between 60% and 79.9%), **moderate** (between 50 and 59.9 %), **poor** (between 49.9 and 30%), and **very poor** (under 29.9%).

Fig. 4. Silicification intensity of microfacies recognized in raw materials from Lespezi-Lutărie site*.

IMPLICATIONS FOR THE UPPER PALAEOLITHIC SITES FROM MIDDLE AND LOWER BISTRIȚA

In absence of dedicated raw material studies, the previous published archaeological research of the UP sites from the Middle and Lower Bistrița Valley comprises enough and consistent elements to portray the petrographic diversity of raw materials (Table 7) and their presumed provenance. But to untangle the lithic acquisition patterns is only partially accomplishable because most of the published data leave out or inconsistently pursue aspects regarding the mode of introduction, operational sequences, technological and typological categories for all raw materials.

The lithic assemblage of level IV of Lespezi-Lutărie is composed of 1355 pieces (from these 19.72% are tools, Bitiri-Ciortescu *et alii* 1989, 28-table 2), with raw materials represented in almost equal amounts by menilite (30.9%) and sandstone (30.8%), followed by many varieties of flint (30.4%) and black schist (7.9%) (Bitiri-Ciortescu *et alii* 1989, p. 15, 27, table 1). For the other layers, rock types used for tool production are also the local ones such as menilite and "pebble grayish sandstone" (which are the predominant rock types in levels VI, V and III), black schist (used in all levels in small quantities, up to 15%), and the distant bluish cretaceous Prut flint of good quality (fine grained) in percentages from 1–13% in levels VI, V and III up to 34% in level II (Bitiri, Căpitanu 1972, p. 48–65; Bitiri-Ciortescu *et alii* 1989, p. 27, table 1). The flint category from all levels is actually greatly diversified and contains beside the Prut flint, other "sedimentary rocks – whitish, yellowish and grayish flints", "volcanic flints" such as "red and yellow jasper, hydrothermal opal – grayish, reddish and yellowish", "obsidian and other patinated volcanic glasses" (Bitiri-Ciortescu *et alii* 1989, p. 14, 21). The local raw materials were considered to come from Bistrița's gravel deposits and some Sarmatian gravels found on the right side of the river (at 500–600 m absolute altitude) between Runcu-Buhuşi and Gârleni (Bitiri, Căpitanu 1972, p. 42). The authors of the excavation consider that the grayish sandstone is the most abundant and easily accessible raw material that was used for tools with basic and broad functions, while the Prut flint was introduced as finished tools (finer implements) or as prepared cores that were completely exhausted (Bitiri, Căpitanu 1972, p. 51). This is contradicted by the fact that many flakes of Upper Cretaceous nodular cherts sampled for this analysis have significant surfaces covered by cortex/neocortex, thus indicating early stages of core preparation and introduction of raw material in more or less unprepared states (Pl. 4–5).

At Buda-Dealul Viilor, a site positioned 8 km (in walking distance) upstream from Lespezi, the same petrographic diversity and same pattern of lithic acquisition was recognized: the bluish Prut flint is the predominant raw material (58.33%), used for most of the tools, and followed by menilite (34.77%), black schist (4%), and sandstone (2%). Some flakes, blades and tools knapped from "black obsidian with white stripes" (Bitiri-Ciortescu *et alii* 1989, p. 22) were also discovered.

Further upstream (around 50 km), near Piatra Neamț, at Poiana Cireşului, the same local raw materials (primarily used) were introduced in the site as rounded pebbles or prismatic blocks collected from the river gravels, being present in all operational sequences, from first detachments with smooth and rounded surfaces to exhausted cores and abandoned tools (Cârciumaru *et alii* 2006, p. 323; 2007a, p. 11–12; Steguweit 2009, p. 34; Steguweit *et alii* 2009, p. 142, 144). The "exogenous Cretaceous flint"/"Cretaceous flint from the Prut valley"/"white-bluish/bluish/brown flint («of Prut»)" and the other two types ("yellowish-brown flint «of the pre-Balkan platform», translucent white-yellowish flint «of Dniester»"), the opal and the jasper were introduced as prepared cores, exhausted tools and blanks (absence of cortical products and decreased length of blades).

In UP sites from Ceahlău Basin, the same petrographic diversity was recognized, differentiating predominantly local available raw materials (such as menilite, Audia black schist, glauconitic siliceous sandstone, and hard blackish sandstone with bluish chalk-like weathered surface) from the distant ones such as flint (Nicolăescu-Plopşor, Petrescu-Dîmbovița 1959, p. 48, 52; Nicolăescu-Plopşor *et alii* 1966, p. 20; Păunescu 1998, p. 102–313). Among the latter category, the materials described were the "white-bluish or gray flint of better quality" (Nicolăescu-Plopşor *et alii* 1966, p. 22, 38), the "yellowish-blue flint" (Nicolăescu-Plopşor *et alii* 1966, p. 53), and the "Prut flint of various shades and good quality" from deposit on Middle Prut Valley (Nicolăescu-Plopşor *et alii* 1966, p. 23–24, 27). Cretaceous flint is associated with different types of consumption that reflect raw material supply strategies and patterns of blank selection and transport: complete operational sequences at Bistricioara-Lutărie (layer II); partially illustrated operational sequences at Ceahlău-Cetățica I (layer II, III), Ceahlău-Podiş (layers II, III, IV) and Bistricioara-Lutărie (layer I, III, IV); heavily fragmented operational sequences at Ceahlău-Dârțu (layer III), Ceahlău-Podiş (layer I), Poiana Cireşului, Buda-Dealu Viilor (layer I) (Steguweit *et alii* 2009, p. 143).

Site	Archaeo-logical layer	Cultural layer	Lithic pieces (no.)	Tools[a] (%)	Raw material types[b]									
					Flint with white-blue patina (%)	Menilite (%)	Black schist (%)	Glauconitic siliceous sandstone (%)	Blackish sand-stone (%)	Quartzitic sandstone (%)	Radiolarite (%)	Spongo-lithic chert (%)	Quartzite (%)	Yellowish marlstone (%)
Bistricioara-Lutărie	I	Aurignacian	1049	8.5	7.7	9.3	30.1	32.4	7.6	0.0	0.0	0.0	0.2	0.3
	II	Gravettian	1038	11.0	34.0	21.4	30.0	9.3	1.7	0.0	0.0	0.0	1.3	0.0
	III	Gravettian	3033	7.2	33.3	28.0	29.0	5.4	1.7	0.0	0.2	0.0	0.4	0.0
	IV	Gravettian	1464	9.2	52.7	32.7	8.0	5.5	0.2	0.0	0.0	0.0	0.0	0.0
	V	Gravettian	859	14.8	49.2	33.5	11.7	2.8	0.2	0.0	0.1	0.0	3.0	0.1
	VI	Gravettian	780	20.1	26.6	58.0	5.3	5.5	0.3	0.0	0.0	0.0	0.0	0.2
Ceahlău-Bofu Mic	II	Gravettin	1526	26.5	37.0	50.0	6.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0
Ceahlău-Cetățica I	I	Aurignacian	152	26.3	++[c]	++	++	++	++	+	–	–	+	–
	II	Aurignacian	214	14.0	20.6	36.0	24.8	4.2	7.0	0.0	0.0	0.0	0.5	1.4
	III	Gravettian	392	9.9	14.3	33.7	22.7	9.4	13.0	0.0	0.0	0.0	0.0	4.3
	IV	Gravettian	213	15.0	32.9	20.7	20.2	9.4	5.2	0.0	0.0	0.0	0.9	10.3
	V	Gravettian	269	14.1	34.6[d]	43.8[e]	10.4	5.2	4.5	1.5	0.0	0.0	0.0	0.0
Ceahlău-Cetățica II	IV	Gravettian	112	8.0	+	+++	+++	+++	–	–	–	–	–	–
Ceahlău-Cetățica III	-	Gravettian	154	9.1	+	+++	+	+	–	–	–	–	–	–
Ceahlău-Cremeniș I	-	Gravettian	76	19.7	+	85.0	+	+	–	–	–	–	–	–
Ceahlău-Dârțu	I	Aurignacian	484	8.5	1.8	6.3	37.0	54.3	0.0	0.0	0.0	0.0	0.0	0.5
	II	Aurignacian	1112	9.3	7.0	12.0	20.0	57.0	0.0	0.0	0.0	3.0	0.0	1.0
	III	Gravettian	192	17.7	43.2	49.5	5.7	1.6	0.5	0.0	0.0	0.0	0.0	0.0
	IV	Gravettian	668	9.6	59.0	31.1	6.9	1.2	0.3	0.0	0.0	0.0	0.9	0.6
	V	Gravettian	9449	6.7	22.7	47.2	24.0	2.6	0.0	0.0	0.7	0.0	0.1	0.7
Ceahlău-Podiș A	I	Aurignacian	357	17.1	11.0	41.0	39.0	33.0	0.0	0.0	0.0	0.0	0.0	0.0
	II	Gravettian	888	10.6	30.3	64.1	1.4	3.3	0.3	0.0	0.6	0.0	0.0	0.0
	III	Gravettian	1877	5.7	43.6	50.2	3.2	2.2	0.8	0.0	0.0	0.0	0.0	0.0
	IV	Gravettian	484	12.0	21.4	62.1	4.3	11.5	0.4	0.0	0.3	0.0	0.0	0.0
	V	Gravettian	3730	9.4	30.0	54.0	11.0	2.8	0.2	0.0	0.4	0.0	0.1	0.4
Izvorul Alb-Culmea Baicului	IV+V	Gravettian	76	3.9	14.5	56.6	18.4	11.8	0.0	0.0	0.0	0.0	0.0	0.0
	Surface	Gravettian	624	10.9	24.0	43.0	26.0	4.0			3.0			
Izvorul Alb-Picior Gol	Surface	Gravettian	299	14.4	74.0	14.0	7.0	2.0			3.0			
Piatra Neamț-Poiana Cireșului	I	Gravettian	41	14.6	4.9	90.2	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	II	Gravettian	1064	8.3	7.0	87.0	1.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0
	III	Gravettian	174	6.9	14.0	84.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Bicaz-Ciungi	-	Gravettian	2335	7.8	22.0	65.0	6.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0
Buda-Dealu Viilor	I[f]	Gravettian	1618	17.9	50.0	41.0	3.0	4.0	0.0	0.0	1.6	0.0	0.1	0.0
	II	Gravettian	138	38.4	55.0	36.0	2.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0
	III	Gravettian	24	50.0	+++	+++	–	+++	–	–	–	–	–	–
Lespezi-Lutărie	VI	Gravettian	504	3.8	+	+	+	+++	–	–	–	–	–	–
	V	Gravettian	1752	2.2	+++	+[g]	–	–	–	–	–	–	–	–
	IV	Gravettian	1355	7.2	75.0			25.0	0.0	0.0	0.0	0.0	0.0	0.0
	III	Gravettian	2260	3.7	87.0-88.0			12.0-13.0	0.0	0.0	0.0	0.0	0.0	0.0
	II[f]	Gravettian	2319	3.7	85.0			14.9	0.0	0.0	0.0	0.0	0.04	0.0
	I	Gravettian	140	11.4	+++	+++	+	+	–	–	–	–	–	–

Table 7. Raw material frequencies in Upper Palaeolithic lithic assemblages from Bistrița Valley.

a) The percentages given in this table were estimated after the number of tools given for each site by Al. Păunescu (1998).
b) Raw material frequencies after Păunescu (1998, p. 102–103, 128–168, 171–174, 181–192, 206–207, 220–240, 243–261, 270–281, 291–297, 302–313).
c) The flint from this level has a blackish or dark gray color (Păunescu 1998, p. 182).
d) This is a translucent grayish flint with bluish or whitish-yellow alteration surfaces (Păunescu 1998, p. 187).
e) For this level the frequency of menilite is omitted, but the percentages of the other raw materials do not make-up 100%.
f) In this layers, Păunescu (1998, p. 292, 305) also mentions as a raw material used a black dull obsidian (0.5% in Layer I of Buda-Dealu Viilor, and one piece in Layer II of Lespezi-Lutărie site).
g) In this level small knapping agglomerations were using as predominant raw materials either the glauconitic siliceous sandstone, or the menilite (Păunescu 1998, p. 312–313).
+ + + - raw material described as being used "especially", "predominantly" ("în deosebi", "în special"), without specifying the percentage.
+ - raw material described as being used "to a lesser extent" ("în mai mică măsură", "în mică măsură", "și mai puțin"), without specifying the percentage.
+ + - two or more raw materials described as being used in almost the same amounts ("both … and from …"/"atât din ... cât și din ..."), without any other specification.
– - raw material absent from the lithic assemblage.

Al. Păunescu frequently refers to flint as "patinated flint" or "flint with bluish or white-bluish patina" (Păunescu 1998, p. 128–129, 137–138, 145–146, 153–154), and rarely mentions a "translucent grayish flint with bluish or white-yellowish alteration surfaces" (Păunescu 1998, p. 187). Once only, he states directly that the Prut Valley flint is "the brownish-orange flint with white-bluish alteration surfaces" (Păunescu 1998, p. 47), considering that what has been called Prut Valley flint in earlier publications has in fact a local origin (Eastern Carpathians).

In the absence of Upper Cretaceous flint sources in this area, the archaeologist explained the presence of this material in UP sites from Bistrița Valley as imports of Prut Valley flint type (Nicolăescu-Plopșor *et alii* 1966, p. 22–23; Cârciumaru *et alii* 2010b, p. 53; Steguweit *et alii* 2009, p. 143), a sign of cultural relations and geographically opened circulation routes between Gravettian communities from Bistrița and Prut valleys. In light of recent petrographic analyses (Crandell *et alii* 2013; this study) the "scarcely verified postulate" of Prut flint imports (Steguweit *et alii* 2009, p. 143), based mainly on visual similarities and the experience of different archaeologists who worked in this area, is getting rounder and heavier. The long-distance raw material acquisition of "yellowish-brown flint «of the pre-Balkan platform»" suggested by (Cârciumaru *et alii* 2007a, p. 11) has also been confirmed by recent petrographic analyses (Crandell *et alii* 2013; this study), indicating provenance from Dobrudja (about 300 km) and the Lower Danube Valley (more specifically the alluvial deposits from Căscioarele-Giurgiu zone, 380-400 km in walking distance). The idea of raw material imports from Lower Danube Valley is also supported by the fact that in the Giurgiu-Malu Roșu site two end-scrapers made of black shale are mentioned (Păunescu, Alexandrescu 1997, p. 19). These facts reflect some kind of reciprocal relations between UP human communities from Lower Danube and Middle and Lower Bistrița valleys.

Besides this specific problem of long-distance imported Upper Cretaceous nodular cherts, the present study gives a more nuanced picture for the petrographic variability of the local raw materials from Lespezi and, through the consistency of previous descriptions, of all sites from the Middle and Lower Bistrița Valley. Because of their local provenance (not so spectacular in terms of transport distance and quite annoying because of their variability, abundance and availability) raw materials from Eastern Carpathian Flysch have been superficially discussed by archaeologists (see above, section 1) and rather disregarded by previous petroarchaeological works (Crandell *et alii* 2013). In all sites from this region, the menilite is depicted as one of the most abundant rock types of the lithic assemblages (see Table 7). But as proven by this analysis, it actually includes different petrographic types of cherts with similar macroscopic features. The menilite and the gray-brownish Eocene chert certainly have a local origin, but their share in the lithic material was obstructed by their amalgamation and confusion with each other and the macroscopically similar grayish chert (variety [04a]), of unknown and remote provenance. The black schist category includes some different types of shales which have a very wide area of occurrence (see above, section 4). The sandstone category contains different petrographic types of coarse-grained rocks (calcarenite, quartzarenite, detrital-rich spiculite chert), which also have a large and geologically diversified distribution in the area. External characteristics of the samples analyzed confirmed that raw materials were collected from alluvial deposits (sub-autochthonous or allochthonous sources, *sensu* Turq 2000, p. 106–107), thus complicating the provenancing efforts.

This petrographic diversity, mistaken with petrographic heterogeneity (Crandell *et alii* 2013, p. 40), reflects the natural occurrence of these rocks in the local geological framework (see Table 1, Pl. 1), occurrence doubled by their presence in various alluvial deposits on rivers and streams that cut across the Eastern Carpathian Flysch in the study area. Faced with this petrographic diversity and abundance in a given landscape one may raise the question of exactly how local a raw material is? To illustrate this I am thinking of the "menilite" in UP sites from Middle Bistrița that may have a rather more remote provenance because these sites are located in a geological landscape (Audia Nappe) abundant in Lower Cretaceous rocks (black shale, sandstones, black cherts) and lacking Paleogene ones, with the Hangu Fm (Tarcău Nappe) composing the bedrock of the opposite side of Ceahlău Mts. (see Table 1, Pl. 1). Paleogene deposits outcrop further downstream (Tarcău Nappe) and eastward (Vrancea Nappe) from the UP sites in Ceahlău

Basin (for the mentioned rock types found in these areas see Păunescu 1998, p. 54–56; Cârciumaru *et alii* 2007c, p. 32, 35). Returning to the geological landscape of Lespezi-Lutărie site, occurrence of Paleogene rocks can be placed immediately westward from the site (Vrancea Nappe), while Lower Cretaceous rocks can be found further to the north-west in Piatra Neamț area (Vrancea Nappe) (see Table 1 and Pl. 1). Given this geological framework, it can be assumed that raw materials supply for Lespezi site was done mainly from alluvial sources in a radius of 50 km (but other and more restricted definitions of local, in terms of distance and petrographic characteristics, may and should be employed).

Looking at the whole picture of raw materials used in the Gravettian sites from Bistrița Valley (Table 7), there is a slight variation as to what raw materials were preferred: in some layers there are three equally used rocks (menilite, "flint" and schist), while in others only two raw materials are equally and predominantly used (menilite and flint), but there are some layers in which predominates just one raw material (menilite). These patterns of raw material acquisition (shift in frequencies of the most used types from one level to another inside the same site or between neighboring sites) suggest that preference was probably controlled also by source accessibility (both in time and in space) and raw material abundance within that source, but also the particular function of the site.

The massive use of Cretaceous flint and menilite, sometimes of black schist in equal amounts also, and the diminished exploitation of sandstones was interpreted as an evolutionary step forward – these are fine-grained materials of good or better knappable quality (easy fracture initiation, fracture predictability). This was the position taken by archaeologist from C. S. Nicolăescu-Plopşor till the present day, though within this interval of time the advances in experimental knapping and knowledge of rock properties allow another angle of interpretation, i.e. coarse-grained materials can be as easily knapped by an experimented knapper, as fine-grained ones and grain dimension is not an issue (Inizan *et alii* 1999, p. 21–23). Also, "voids and impurities" inside a rock will cause an irregular fracture (Brantingham *et alii* 2000, p. 260). Another overlooked fact is that prehistoric raw material acquisition strategy might have followed rock properties other than fracture predictability, such as edge durability which is associated with coarse-grained materials (Braun *et alii* 2009, p. 1607). Raw materials determined in this study have textures from very fine-grained (black shale) to coarse-grained (quartzarenites), but only a few are low in "voids and impurities" (bioclasts, whole microfauna individuals or detrital quartz grains). The silicification degree (Fig. 4), which may give an overall homogeneity and durability of these materials, goes from very poor (in sandstone varieties and black shale) to strong (in menilite, peloidal chert, grayish-brownish Eocene chert, some Upper Cretaceous nodular cherts), and very strong (only Upper Cretaceous nodular cherts). As a consequence, the preference and use of variable rock types with different grain dimensions at Lespezi-Lutărie and other sites should not be merely described in terms of good versus bad quality knappable raw-materials.

It should be considered that raw material acquisition patterns of the Gravettian communities from the Middle and Lower Bistrița Valley might reflect the combination between local occurring, readily available and accessible rocks (small radius around the site, but variable from Middle to Lower Bistrița sites) with certain characteristics for which they were employed, some more or less remote raw materials (such as the "menilite", also with variable transport distances from Middle to Lower Bistrița sites), and the long-distance imported raw materials (the Prut flint from about 150 km and the Lower Danube Upper Cretaceous nodular cherts from about 400 km) used probably for some other reasons than purely technological ones.

CONCLUSIONS

The present petrographic analysis of the raw materials from Lespezi-Lutărie (level IV) established 16 varieties pertaining to different rock types: sandstones (varieties [01b], [01c] and [01d]), black shale (varieties [02b] and [02c]), bedded cherts (varieties [01a] and [03]), grayish-brownish Eocene chert (variety [04b]), peloidal cherts (variety [02a]) and Upper Cretaceous nodular cherts (varieties [04a], [05a]-[05d]). This analysis is not complete because some other observed raw materials were determined only as macroscopic varieties and further investigations are necessary.

Part of the varieties identified in level IV of Lespezi-Lutărie site reflect the availability, abundance, accessibility and variability of raw materials in the surrounding area (Tarcău and Vrancea nappes), while the ones transported from other regions represent imported materials related to cultural relations and geographically opened circulation routes among the Gravettian communities from Bistrița, Prut and Danube valleys. The use of both coarser (sandstones) and fine-grained lithologies (shale, cherts), from poorly silicified (sandstones, shale) to strongly and very strongly silicified (nodular cherts from chalk) reflects acquisition patterns guided by specific needs and uses of tools. External macroscopic features indicate secondary sources (alluvial deposits, riverbeds) for all varieties determined in this study.

Although some of the raw materials might have the same source (an alluvial deposit), the same geological age (namely pertaining to deposits of the same geological period or stage), or their primary deposits may be situated close in space, they should not be described and regarded as a single raw material type. They can only be considered as such only from the supply distance point of view, while frequency (abundance) inside the lithic assemblage might have different meanings and interpretations.

In spite of an early and good start regarding raw materials characterization and provenance, previous archaeological research has been so much focused on typology and technology, and tangled up in chronology and stratigraphy problems, that eventually has left out and almost completely neglected acquisition and exploitation of rocks (and all that might result from such an analysis). In their effort to describe and determine the provenance of stones used by prehistoric man for tools, some researchers did not pass "beyond the veil" of visual similarities/differences and beyond the fast purpose of establishing regionally recognizable raw material types and trade routes of these raw-materials.

ACKNOWLEDGMENTS

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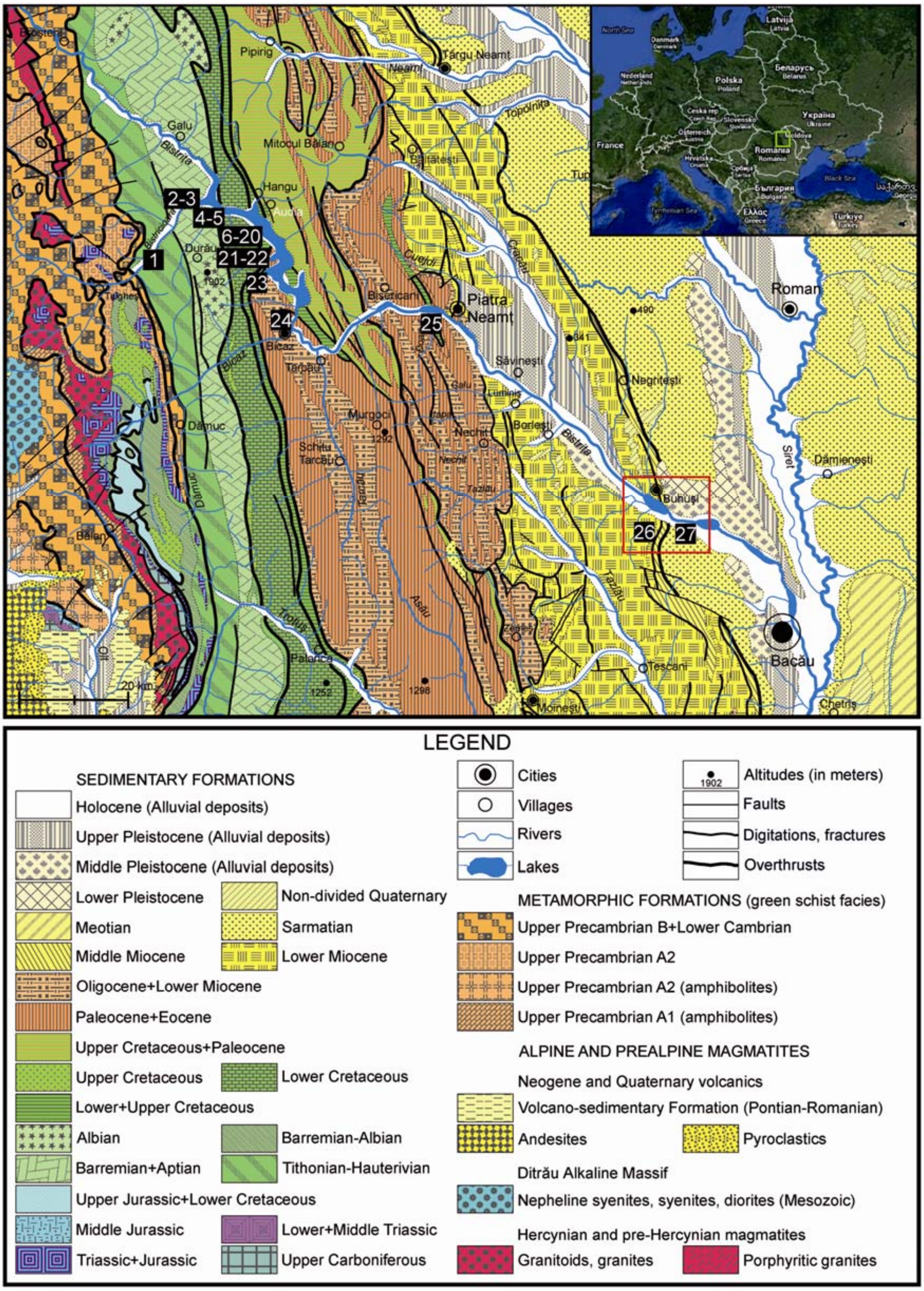

Plate 1. Location and geological context of Upper Palaeolithic sites from the Middle and Lower Bistrița Valley: 1. Bradu-Pârâul lui Oloi La Râpă; 2.–3. Grințieș-Frasinu I-II; 4. Bistricioara-Lutărie; 5. Bistricioara-Lutărie La Mal; 6.–7. Ceahlău-Cremeniș I-II; 8. Ceahlău-Bofu Mic; 9. Ceahlău-Bofu Mare; 10.–13. Ceahlău-Cetățica I-IV; 14. Ceahlău-Curtea Bisericii Vechi; 15. Ceahlău-Dârțu; 16. Ceahlău-Schitișor; 17. Ceahlău-Palatul Cnejilor; 18. Ceahlău-Lutărie; 19. Ceahlău-Podiș A-B; 20. Schitu-Curtea Bisericuței de lemn Schitișor; 21. Izvorul Alb-Culmea Baicului; 22. Izvorul Alb-Piciorul Gol; 23. Secu-Curtea Boului; 24. Bicaz-Ciungi; 25. Piatra Neamț-Poiana Cireșului; 26. Buda-Dealu Viilor; 27. Lespezi-Lutărie; mapping of sites has been done after Păunescu 1998 and Steguweit *et alii* 2009; map support was redrawn and modified after a part of the Geological Map of Romania 1: 1000000 (Săndulescu *et alii* 1978).

Plate 2. Macroscopic view of raw materials from Lespezi-Lutărie (level IV): 1. Sandstones (varieties [01a] to [01d]); 2.–4. Black shale (variety [02b]); 5. Carbonate shale (variety [02c]); rounded and smoothened surfaces indicating water transport (black arrows); scales are 2.5 cm; photos by Al. Ciornei (2013).

Plate 3. Macroscopic view of raw materials from Lespezi-Lutărie (level IV): 1. Menilite (variety [03]); 2. Gray-brownish chert (variety [04b]); "fresh cortex" with slight traces of water smoothening (white arrows); scales are 2.5 cm; photos by Al. Ciornei (2013).

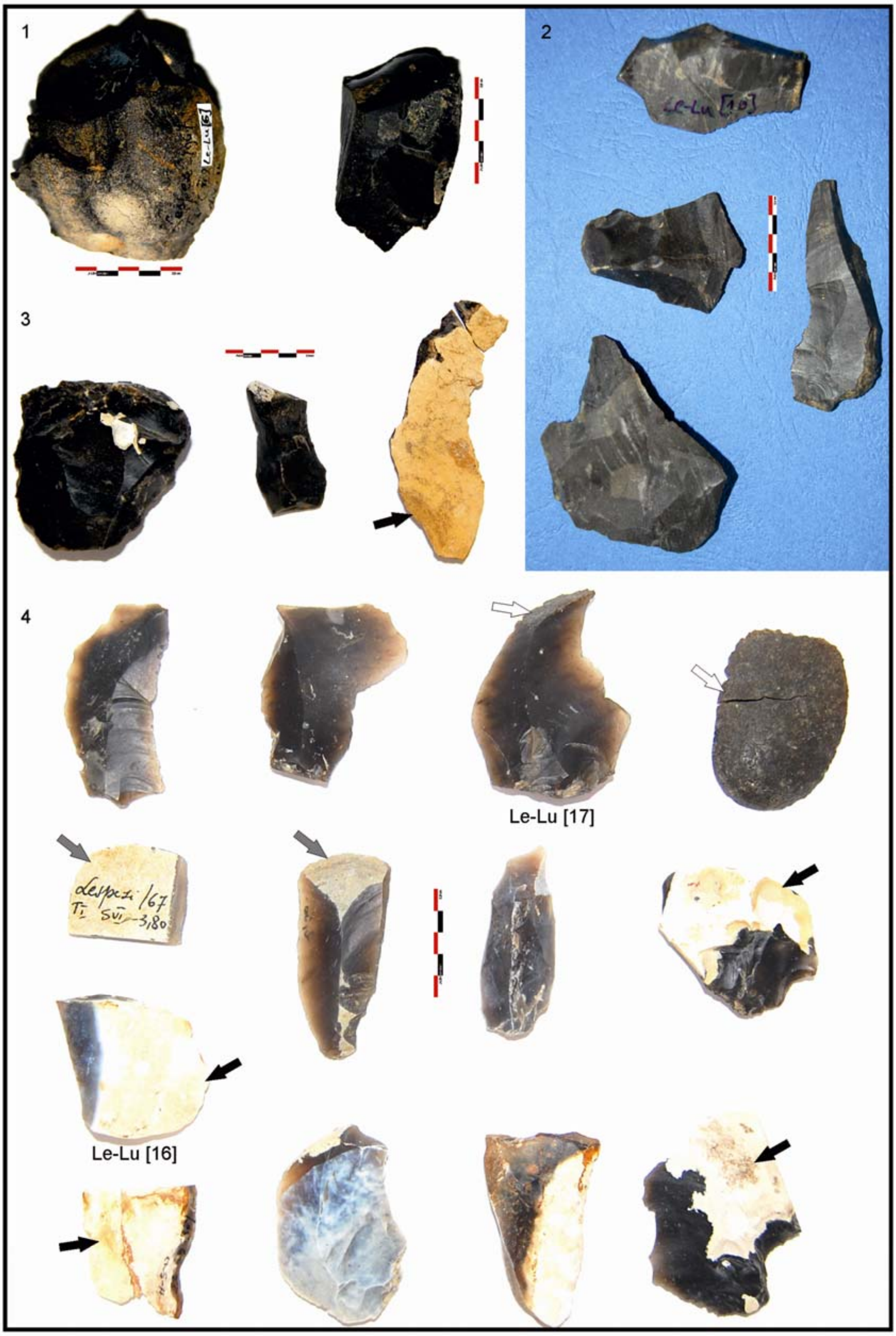

Plate 4. Macroscopic view of raw materials from Lespezi-Lutărie (level IV): 1. Black nodular chert with vitreous luster (variety [02a]); 2. Grayish nodular chert (variety [04a]); 3. Translucent black nodular chert (variety [05a]); 4. Very translucent black nodular chert (varieties [05bc] and [05b]); water transport marks found as slightly smoothened surfaces on "fresh cortex" (black arrows), thin remnant cortical surfaces (gray arrows), or as neocortex (white arrows); scales are 2.5 cm; photos by Al. Ciornei (2013).

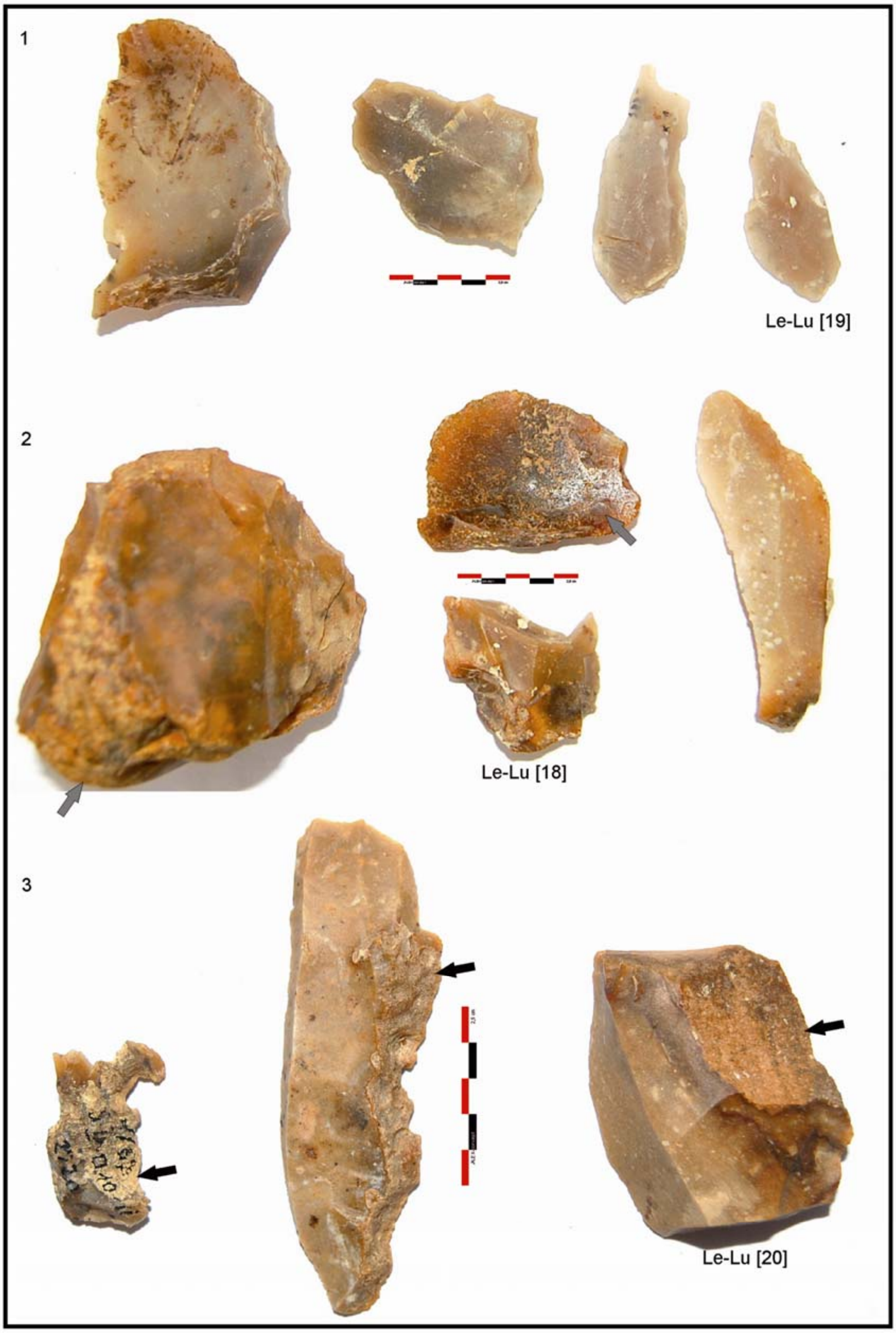

Plate 5. Macroscopic view of raw materials from Lespezi-Lutărie (level IV): 1. Very translucent grayish-brown nodular chert (variety [05cd]); 2. Beige-cream nodular chert (variety [05c]); 3. Yellowish-brown nodular chert (variety [05d]); water transport marks as thin remnant cortical surfaces (black arrows) or as neocortex (gray arrows); scales are 2.5 cm; photos by Al. Ciornei (2013).

Plate 6. Macroscopic view of raw materials from Lespezi-Lutărie (level IV): 1. Varieties separated on macroscopic features only (chert varieties [05e] to [05k]), but not sampled for thin section preparation and microscope analysis; 2.–3. Cherts with pink/bluish alteration surfaces that impede designation to one of the established varieties; scales are 2.5 cm; photos by Al. Ciornei (2013).

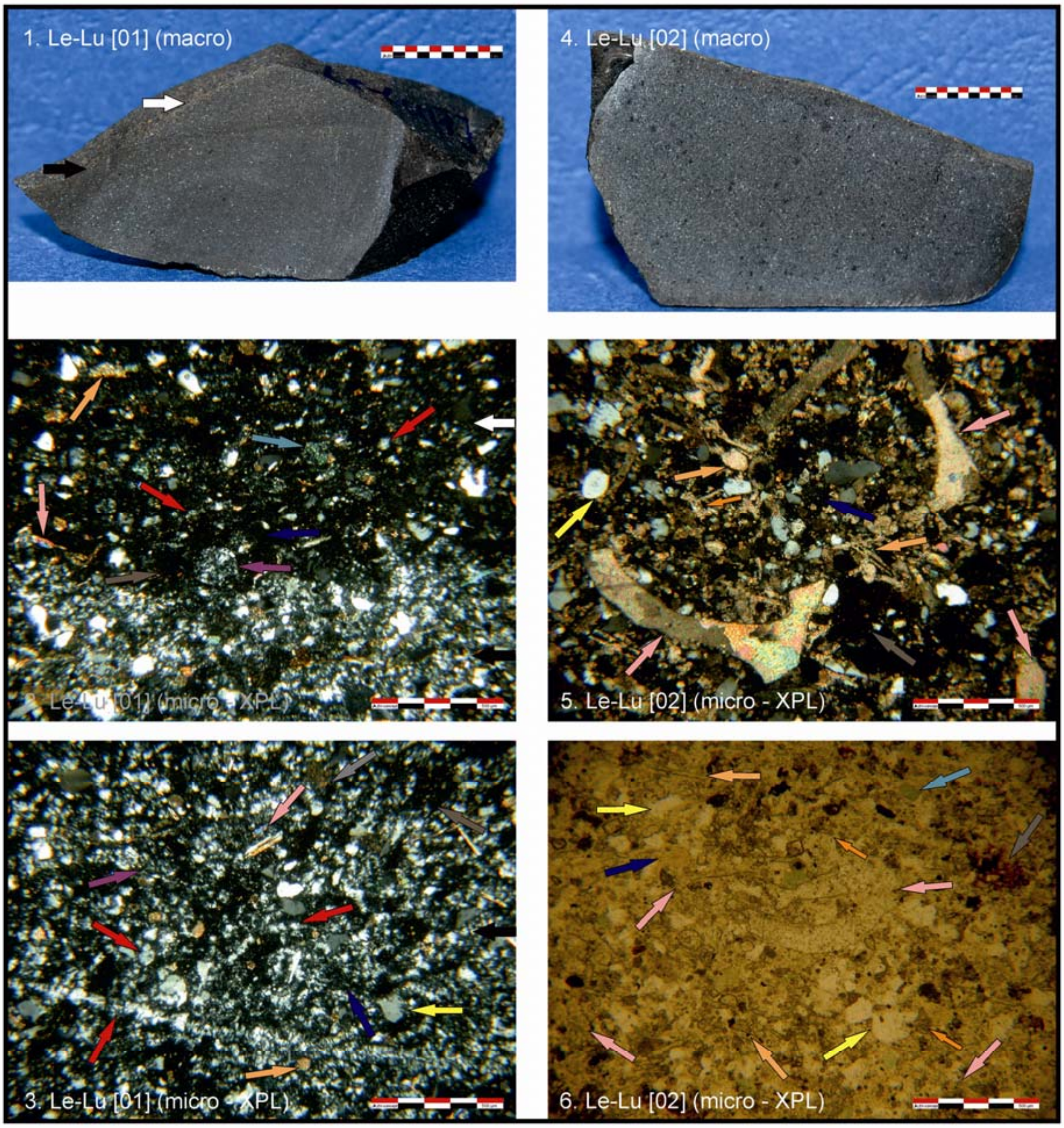

Plate 7. 1.–3. Detrital-rich spiculite chert from Lespezi-Lutărie ([01a]): dark gray with small whitish and black dots, dull, translucent; detrital-rich spiculite chert with packstone depositional fabric (black arrows) fining-upward into a silicified quartz graywacke (white arrows); these two microfacies are both composed of sponge spicules (red arrows) and radiolarians (purple arrows) passed through a mold stage (filled-up by chalcedony), fragmented echinoderm plates (light orange arrows), silicified (blue arrows), carbonate (gray arrow) and glauconite peloids (green arrows), detrital quartz (yellow arrows), sedimentary lithoclasts (brown arrows), and phyllosilicate grainclasts (pink arrows); the intergranular chalcedony cement was precipitated after the dissolution of an early diagenetic syntaxial calcite overgrowth cement on echinoderm fragments; the small amount of matrix was replaced by cryptocrystalline quartz; 4.–6. Calcarenite from Lespezi-Lutărie ([01b]): dark gray with black spots, dull, translucent; packstone depositional fabric, with broken bivalve shells (pink arrows) and fragmented echinoderm plates (light orange arrows), detrital quartz (yellow arrows), silicified (blue arrows) and glauconite peloids (green arrows), sedimentary lithoclasts (brown arrows); particles are held together by a syntaxial calcite overgrowth cement (darker orange arrows) on echinoderm plates, partially replaced by cryptocrystalline 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 (2013-2014).

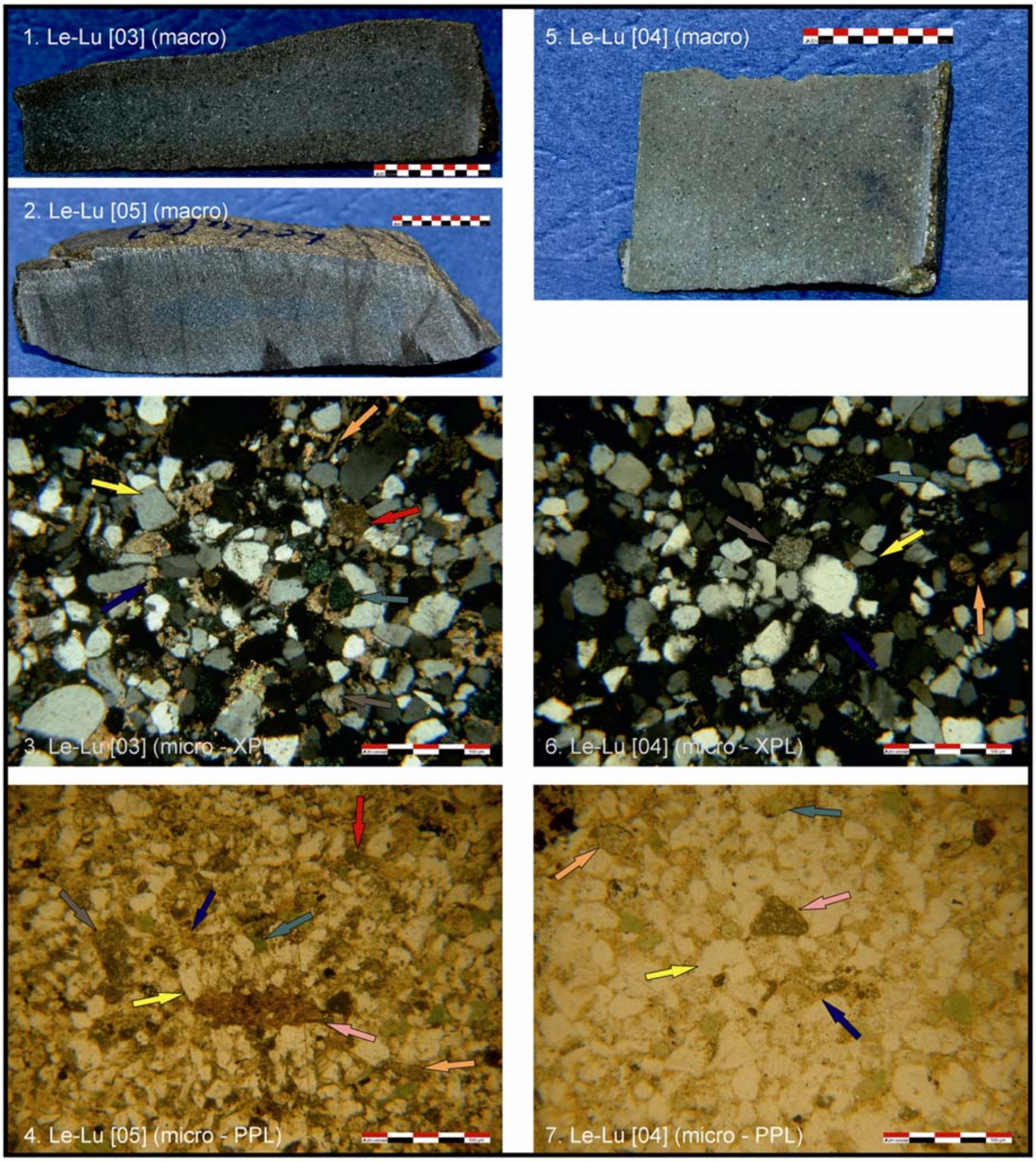

Plate 8. 1.–4. Calcareous quartzarenite from Lespezi-Lutărie ([01c]): medium gray, dull, semi-translucent; composed of subangular to subrounded fine sand particles, mainly mono- and polycrystalline quartz (yellow arrows), feldspars (brown arrows), sedimentary lithoclasts (pink arrow), echinoderm plates (light orange arrows), carbonate (red arrows) and glauconite (green arrows) peloids, with sparry calcite cement (blue arrows) partially replaced by cryptocrystalline quartz; predominance of tangential, point and concavo-convex contacts between particles and deformation of glauconite peloids (green arrow) and sedimentary lithoclasts (pink arrow) suggest strong compaction; 5.–7. Glauconitic siliceous quartzarenite from Lespezi-Lutărie ([01d]): greenish-gray color, dull, translucent; moderate sorting, subangular to subrounded fine to medium sand particles; framework grains are represented by mono- and polycrystalline quartz (yellow arrows), feldspars (brown arrows), sedimentary lithoclasts (pink arrow), echinoderm plates (light orange arrows), and glauconite peloids (green arrows), intergranular space being cemented by cryptocrystalline quartz; tangential and point contacts between particles and no deformation of glauconite peloids imply a lower degree of compaction compared with the calcareous quartzarenite; macro photos – scales are 1 cm; micro photos – scales are 500 µm; XPL – cross-polarized light; PPL – plane-polarized light; photos by Al. Ciornei (2013-2014).

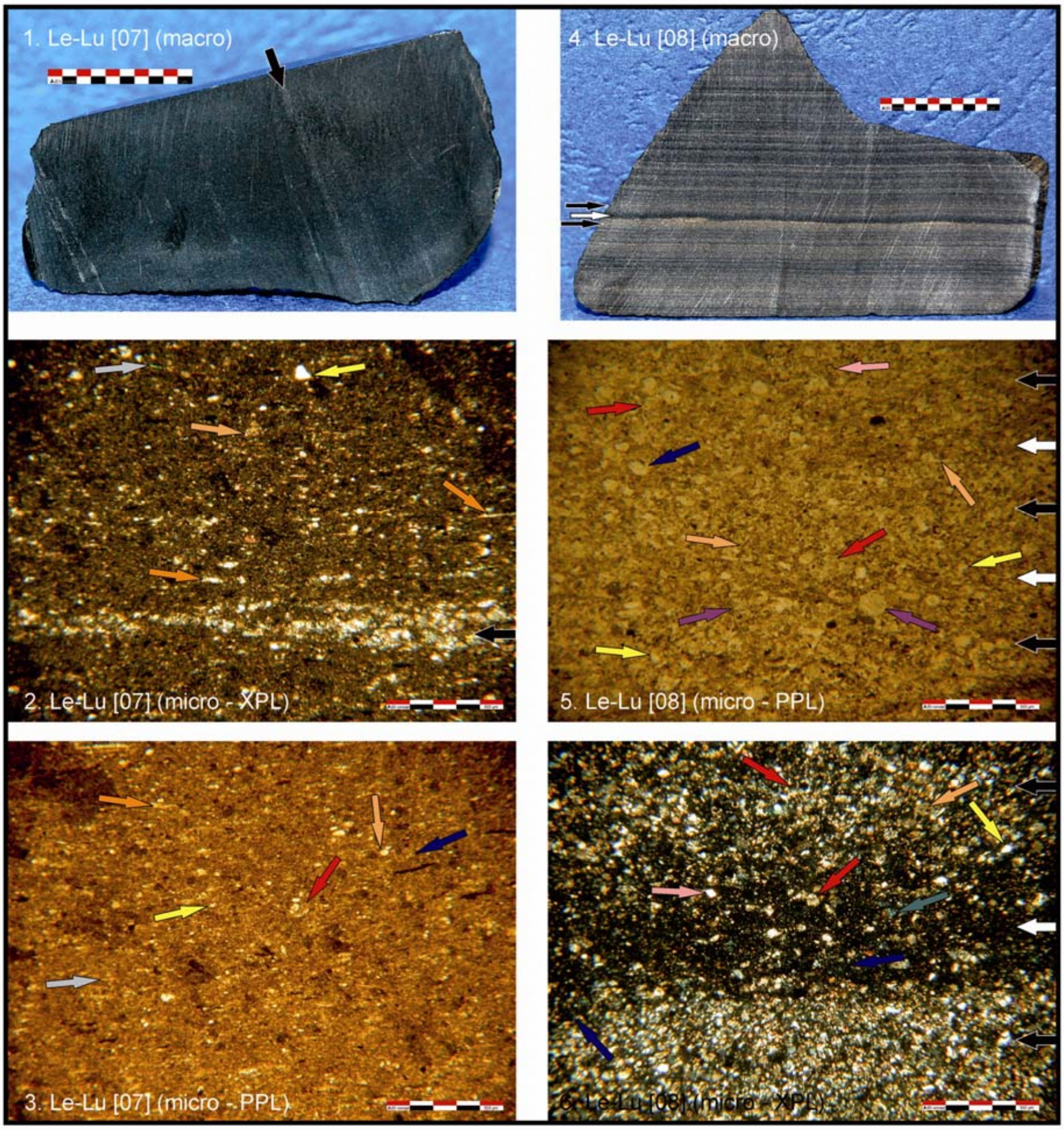

Plate 9. 1.–3. Black shale from Lespezi-Lutărie ([02b]): dark gray-blackish with rare whitish thin laminae, dull, opaque; mudstone depositional fabric, medium to coarse silt sized particles supported by a partially silicified (cryptocrystalline quartz) clay matrix; particles are represented by fragmented and abraded echinoderm plates (orange arrows), ostracodes shell fragments (light orange arrows), planktonic foraminifera (red arrow), radiolarians (blue arrow), quartz (yellow arrows) and clay (gray arrow) grainclasts; faint lamination (black arrows) is given by concentration of fragmented echinoderm plates and ostracode shell fragments; alignment of clay grainclasts and shell fragments with their long axis parallel to the bedding plane suggest compaction and rearrangement of grains; 4.–6. Carbonate shale from Lespezi-Lutărie ([02c]): alternating laminae of thin blackish mudstone (white arrows) and gray-whitish wackestone (black arrows), dull, opaque; fine to coarse silt sized particles, mainly silicified (blue arrows) or calcareous (purple arrows) radiolarians, fragmented and rounded echinoderm plates (light orange arrows), planktonic foraminifera (red arrows), detrital quartz (yellow arrows), clay grainclasts; grains are supported by a partially silicified (cryptocrystalline quartz) micrite matrix with recrystallized calcite rhombs (pink arrows), very abundant in some of the wackestone laminae; macro photos – scales are 1 cm; micro photos – scales are 500 μm; XPL – cross-polarized light; PPL – plane-polarized light; photos by Al. Ciornei (2013-2014).

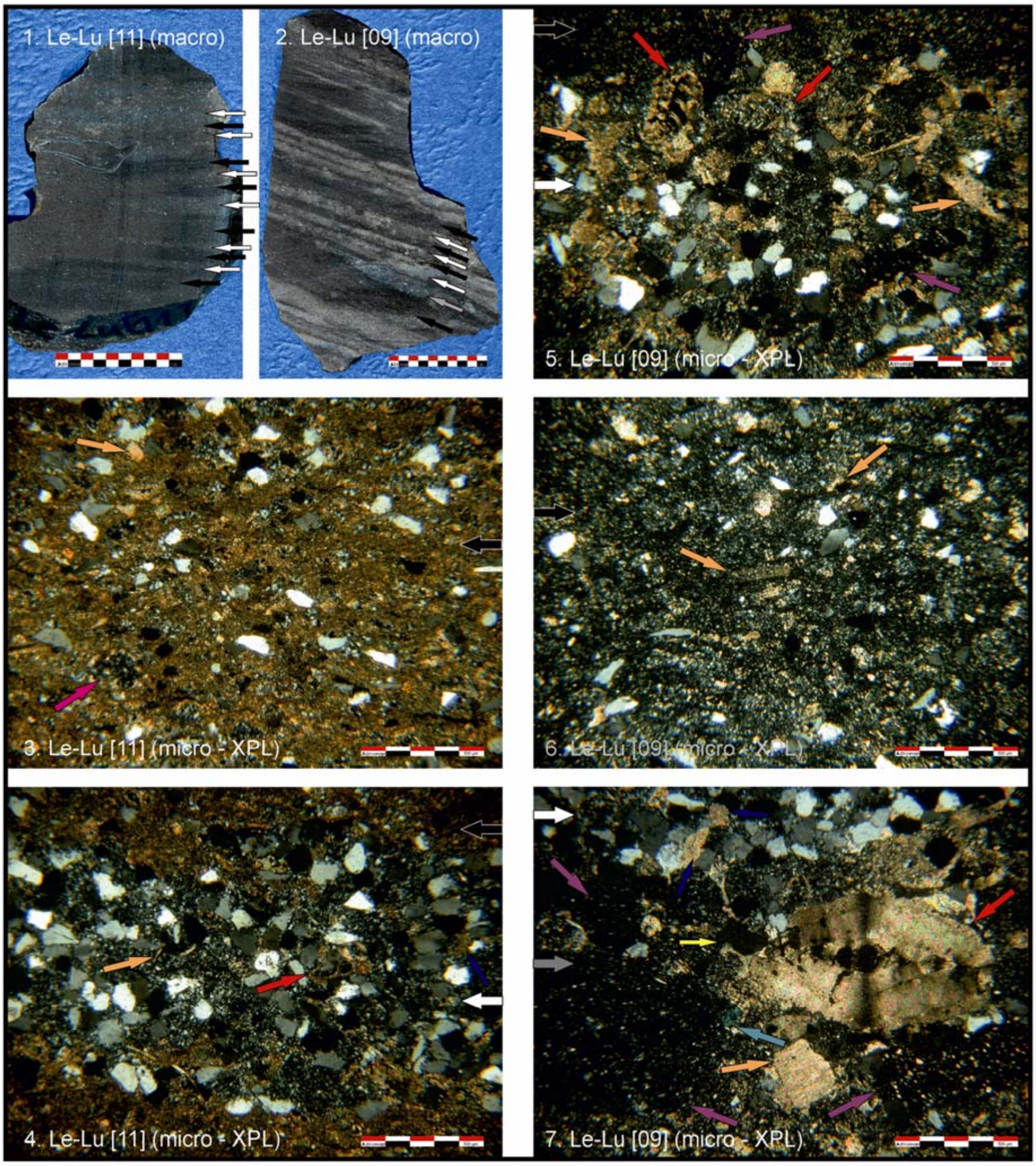

Plate 10. Menilite from Lespezi-Lutărie ([03]): alternating clear medium gray laminae (black arrows) and gray-whitish lamine (white arrows), greasy luster, semi-translucent; detrital-rich bioclastic wackestone (black arrows) composed of fragmented echinoderm plates (light orange arrows) and calcareous algae, sponge spicules, benthic and planktonic (pink arrow) foraminifera in a carbonate matrix (sample Le-Lu [11]) or matrix replaced by cryptocrystalline quartz (sample Le-Lu [09]); quartzarenite (white arrows) with detrital quartz, echinoderm plates (light orange arrows) with syntaxial calcite overgrowth cement (blue arrows) and benthic foraminifera (red arrows), and chalcedony cement; larger benthic foraminifera are present at the top (5) or inside the quartzarenite laminae (4); intraclasts (purple arrows) are present either as separate lamina (gray arrow – intraclast grainstone) or spread across the other fabrics; larger benthic foraminifera such as the specimen of genus *Nummulites* Lamarck (7), and intraclasts point to shallow inner platform settings, but mixing with planktonic foraminifera and detrital quartz indicates transport in deep water settings and resedimentation; macro photos – scales are 1 cm; micro photos – scales are 500 µm; XPL – cross-polarized light; photos by Al. Ciornei (2013-2014).

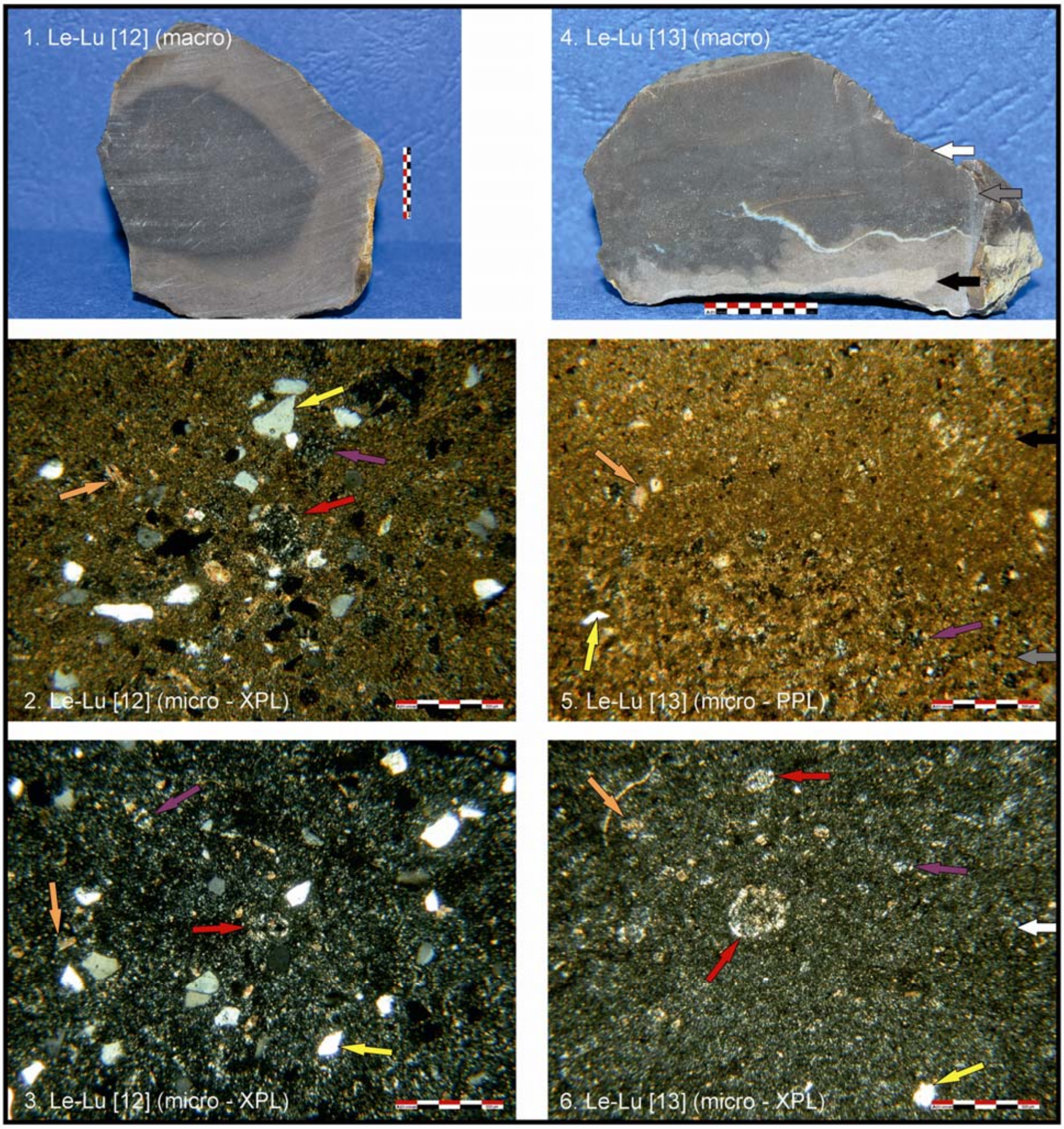

Plate 11. 1.–3. Detrital-rich bioclastic chert from Lespezi-Lutărie ([04b]): medium gray, greasy luster, semi-translucent; wackestone depositional fabric with fragmented echinoderm plates (light orange arrows), planktonic (red arrows) and benthic foraminifera, radiolarians (purple arrows), quartz (yellow arrows) and clay grainclasts, floating in a matrix replaced by cryptocrystalline quartz; in sample Le-Lu [12] there are no compositional differences between the cortex (2) and the siliceous mass (3); 4.–6. Microfacies transitions in sample Le-Lu [13]: from a micrite limestone (black arrows) with very few bioclasts (mainly echinoderm fragments) to a limestone with radiolarian molds (gray arrows) in a sparite cement on fragmented echinoderm plates, to detrital-rich bioclastic chert (white arrows) with a much lower quantity of detrital quartz and a higher amount of radiolarians, but with the same planktonic foraminifera as in sample Le-Lu [12]; macro photos – scales are 1 cm; micro photos – scales are 500 µm; XPL – cross-polarized light; PPL – plane-polarized light; photos by Al. Ciornei (2013-2014).

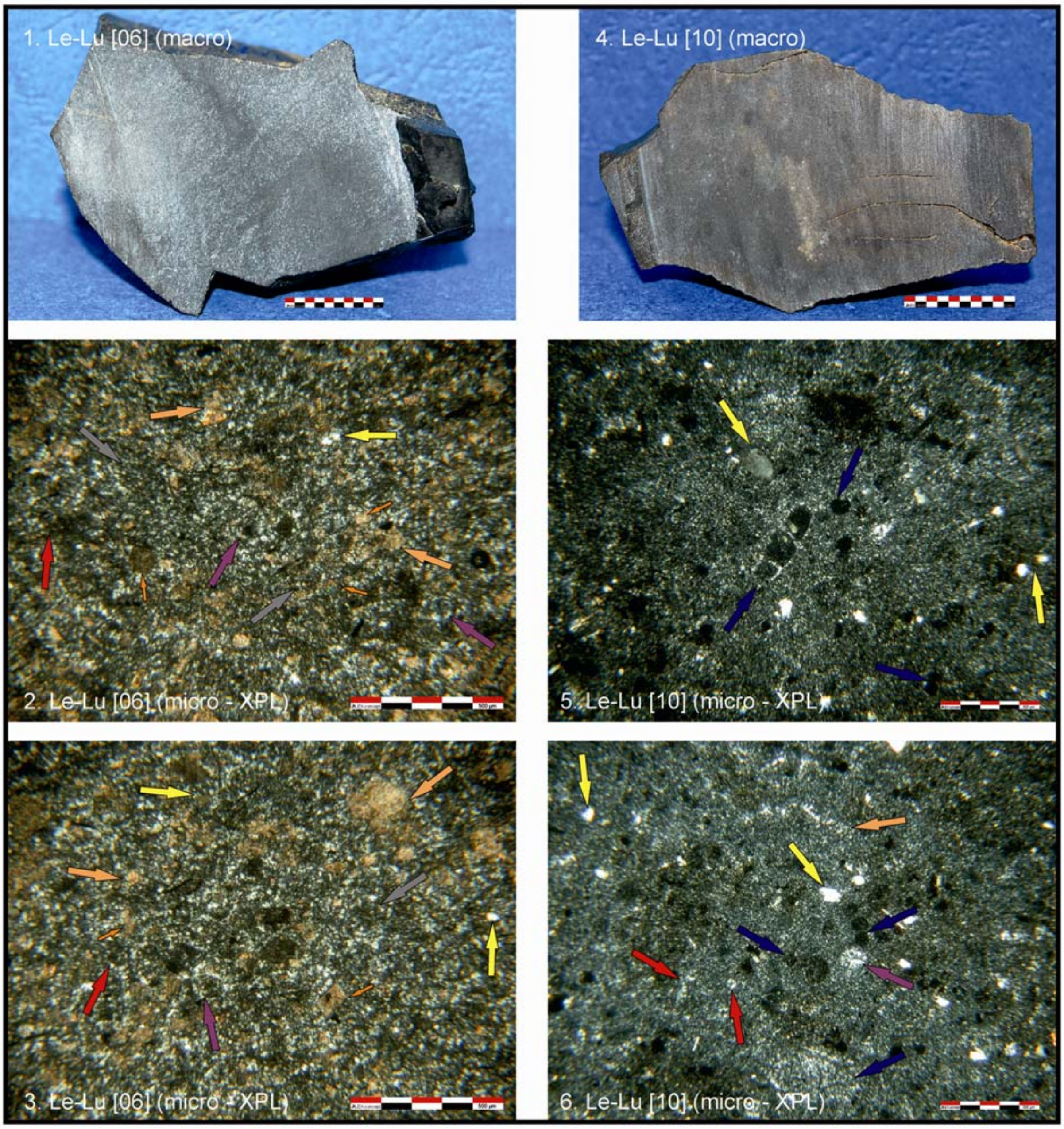

Plate 12. 1.–3. Peloidal chert from Lespezi-Lutărie ([02a]): very dark gray to black color, vitreous luster, translucent; nodular chert with packstone depositional fabric composed of silicified peloids (gray arrows), fragmented echinoderm plates (light orange arrows) with syntaxial calcite overgrowth cement (orange arrows), radiolarian molds (purple arrows), sponge spicules (red arrows) and quartz grainclasts (yellow arrows); the calcite cement was dissolved and the intergranular space filled-up by chalcedony cement (probably at the same time with the radiolarian molds); the micrite matrix and the micrite peloids were replaced by cryptocrystalline quartz; 4.–6. Grayish Upper Cretaceous nodular chert ([04a]): medium gray color, greasy luster, semi-translucent; wackestone depositional fabric with planktonic foraminifera (blue arrows), sponge spicules (red arrows), rare small fragments of silicified echinoderms (light orange arrows), and high siliciclastic input, mainly quartz grainclasts (yellow arrows); particles are supported by a cryptocrystalline quartz replaced matrix; macro photos – scales are 1 cm; micro photos – scales are 500 µm; XPL – cross-polarized light; photos by Al. Ciornei (2013-2014).

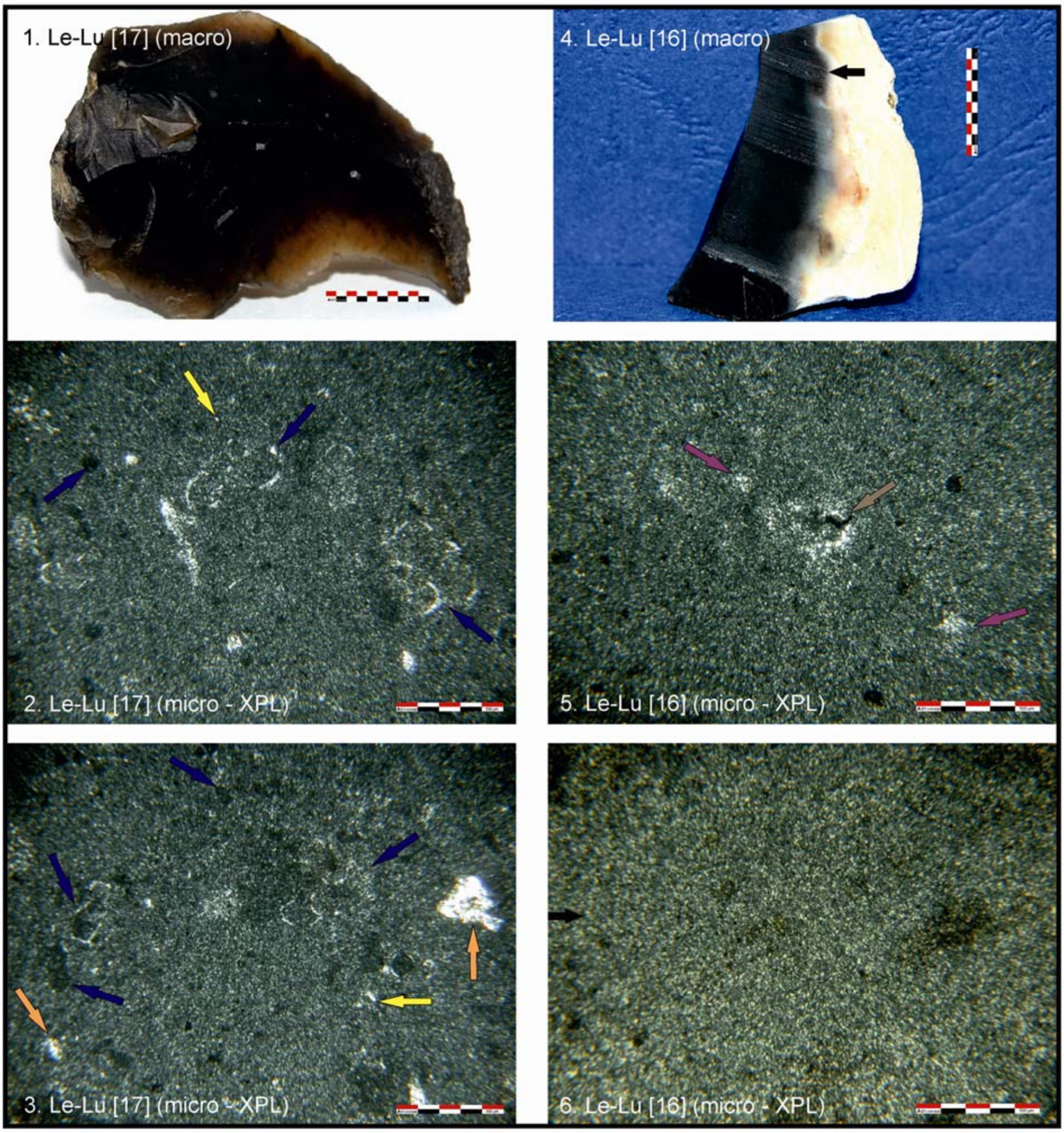

Plate 13. 1.–2. Globotruncanidae chert from Lespezi-Lutărie ([05bc]): clear black color, greasy luster, very translucent; wackestone depositional fabric with matrix supporting abundant planktonic foraminifera (blue arrows), fragments and fragmented algae and echinoderm plates (light orange arrows); matrix was replaced by a cryptocrystalline quartz cement; 4.–6. Cementstone chert from Lespezi-Lutărie ([05b]): very dark gray, greasy luster, very translucent; mudstone depositional fabric composed of a micrite matrix fully replaced by cryptocrystalline quartz, rare foraminifera (brown arrow) and radiolarians (purple arrows), with clear light gray areas (black arrows) representing bioturbation features composed of microcrystalline quartz (probably a recrystallized siliceous ooze); macro photos – scales are 1 cm; micro photos – scales are 500 µm; XPL – cross-polarized light; photos by Al. Ciornei (2013-2014).

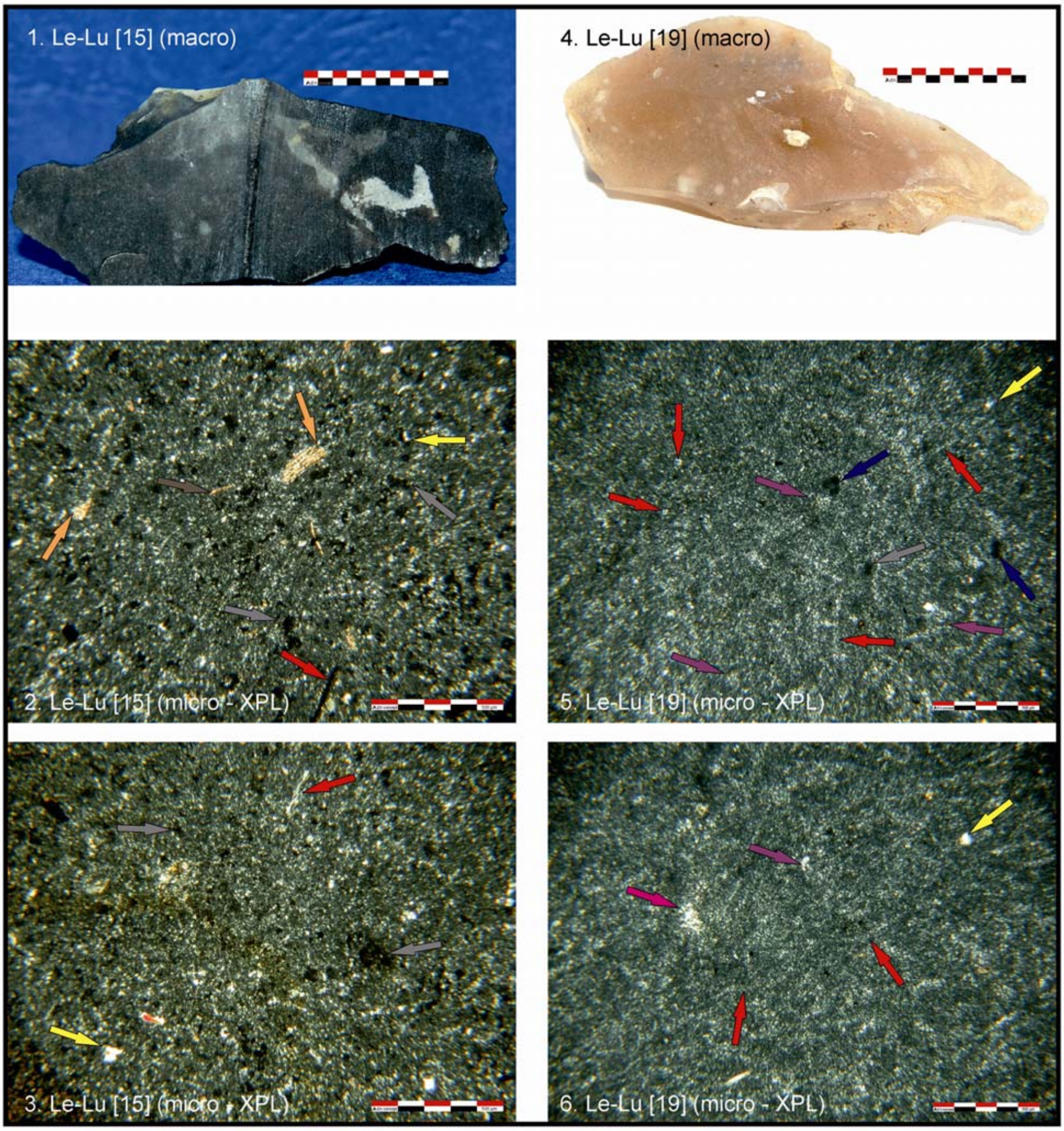

Plate 14. 1.–3. Bioclastic chert from Lespezi-Lutărie ([05a]): bluish dark gray color, greasy luster, translucent; wackestone depositional fabric with a very low percentage of grains, mostly fragmented silicified echinoderm plates (light orange arrows), sponge spicules (red arrows), planktonic foraminifera, small peloids (gray arrows) representing fecal pellets, quartz (yellow arrows) and clay (brown arrow) grainclasts; matrix was replaced by cryptocrystalline quartz cement; 4.–6. Spiculite chert from Lespezi-Lutărie ([05cd]): clear grayish-brown color, greasy luster, very translucent; wackestone depositional fabric with fine sand particles supported by cryptocrystalline quartz cement replacing the matrix; predominant grains are sponge spicules (red arrows), radiolarians (purple arrow), planktonic (blue arrows) and benthic (pink arrow) foraminifera, rare small peloids (gray arrow) and quartz grainclasts (yellow arrows); macro photos – scales are 1 cm; micro photos – scales are 500 µm; XPL – cross-polarized light; photos by Al. Ciornei (2013-2014).

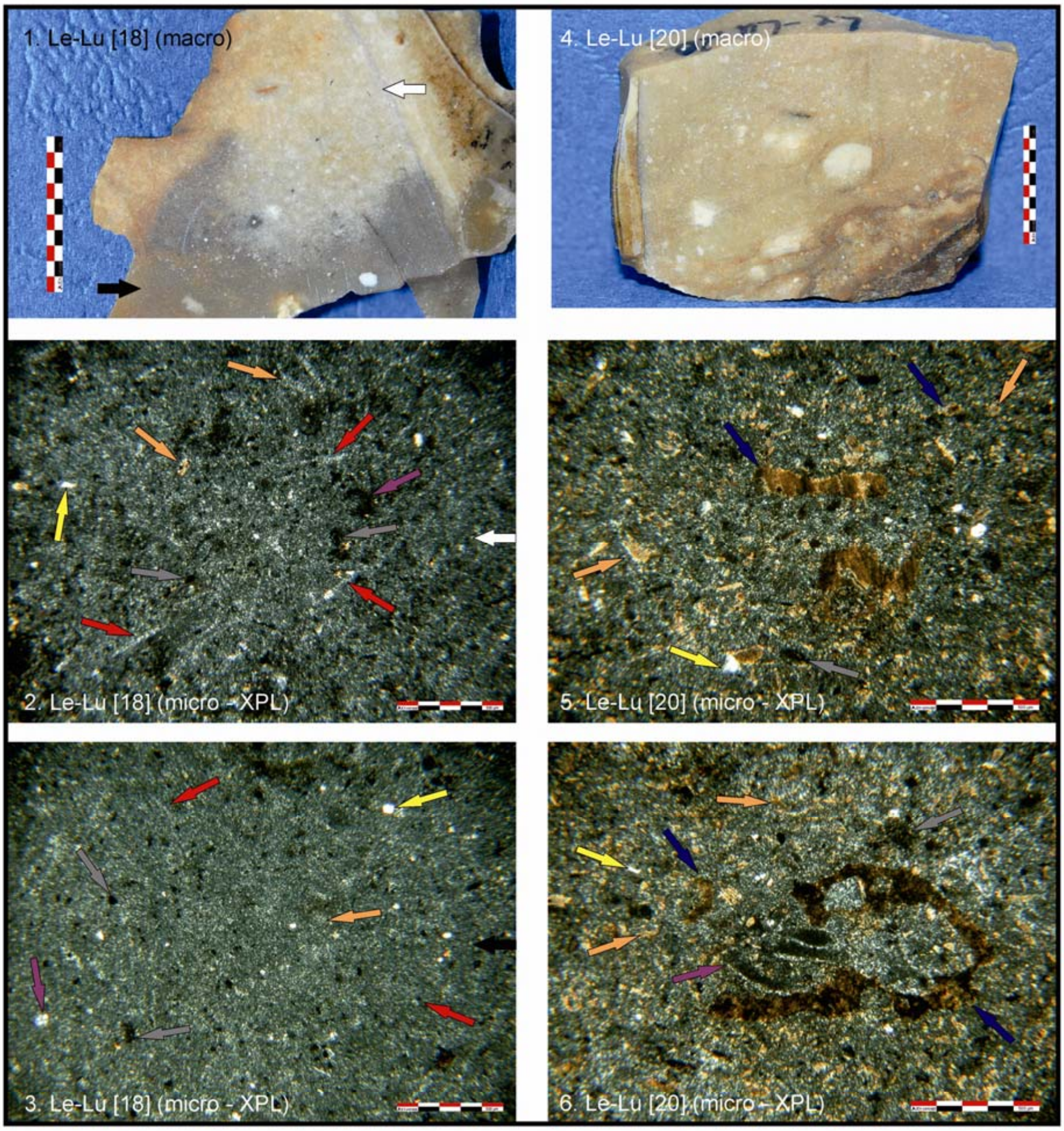

Plate 15. 1.–3. Bioclastic-spiculitic chert from Lespezi-Lutărie ([05c]): beige-cream (white arrow) with gray-brownish areas (black arrow), dull, semi-translucent to translucent; composed of two depositional fabrics, wackestone (white arrow) and mudstone (black arrow), with different amounts of the same grains supported by cryptocrystalline quartz cement replacing the matrix; both fabrics comprise sponge spicules (red arrows), silicified fragments of echinoderm plates and algae (light orange arrows), benthic and planktonic foraminifera, radiolarians (purple arrows), small peloids (gray arrows), and a low amount of quartz grainclasts (yellow arrows); the predominant grain size in the wackestone fabric is fine sand (the majority of sponge spicules fragments are between 100 and 250 µm), while the mudstone is composed mostly of coarse silt sized particles and lacks benthic foraminifera; this suggests that the mudstone fabric might represent a biotic structure disturbing the sediment; 4.–6. Phosphatized bioclastic chert from Lespezi-Lutărie ([05d]): yellowish-brown color, spotted look given by whitish carbonate reminiscences, greasy luster, semi-translucent; wackestone depositional fabric with very fine sand-sized particles floating in a matrix replaced by cryptocrystalline quartz cement; predominant grains are fragmented echinoderm plates (light orange arrows) and algae (blue arrows), benthic agglutinated foraminifera (purple arrow), planktonic foraminifera (from Heterohelicidae family), small peloids (gray arrows) and quartz gainclasts (yellow arrows); whole or very little fragmented algae and echinoderm plates are common feature of this microfacies; macro photos - scales are 1 cm; micro photos - scales are 500 µm; XPL - cross-polarized light; photos by Al. Ciornei (2013-2014).

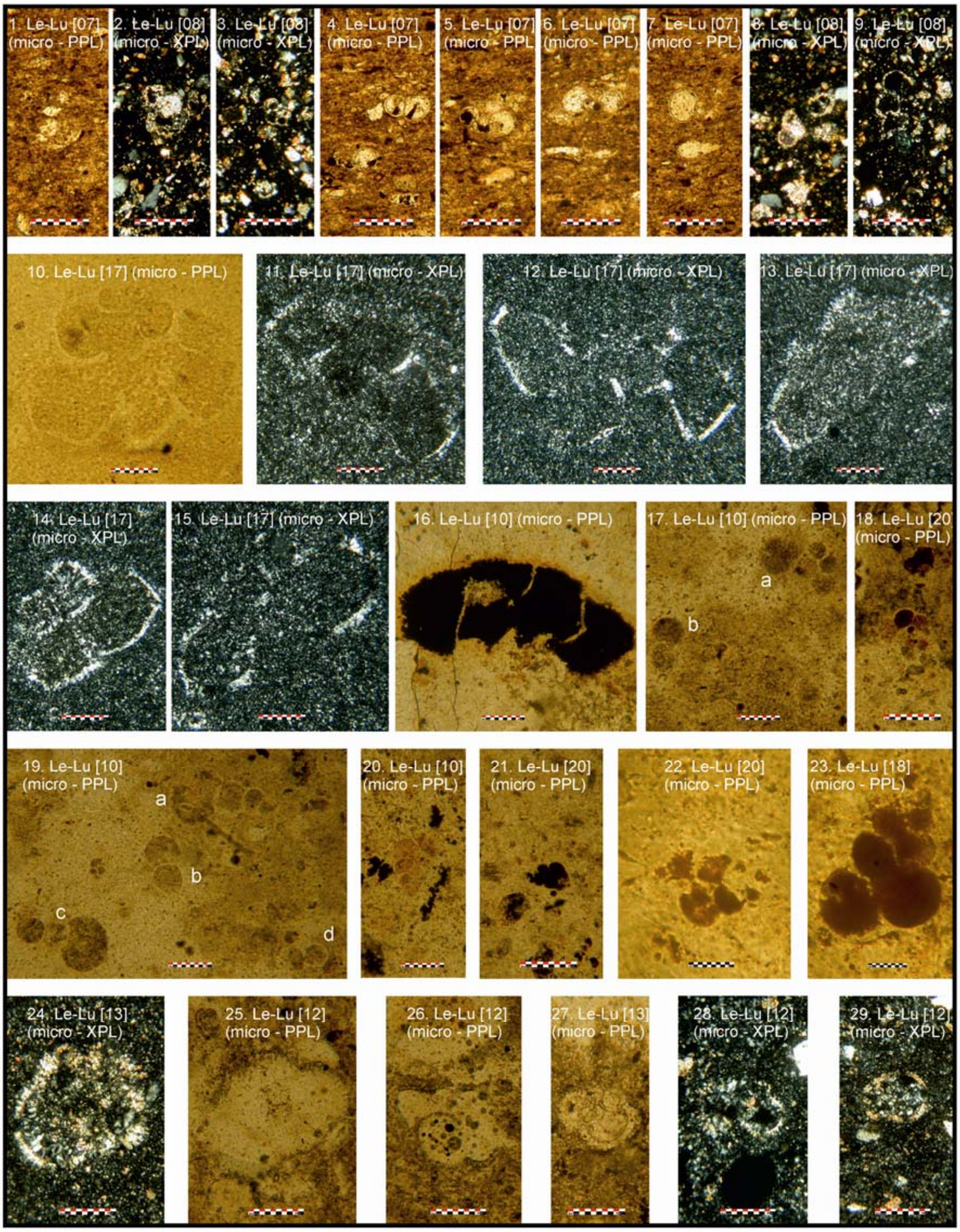

Plate 16. Lespezi-Lutărie raw-materials: transversal (1–3) and axial (4–9) sections through planktonic foraminifera of undetermined family or genus; transversal (10) and axial (11–16) sections through foraminifera from *Globotruncana* Cushman genus (Globotruncanidae family, superfamily Globigerinoidea; genus range from Late Coniacian to Maastrichtian, BouDagher-Fadel 2013, p. 67–68); transversal (17a, 18) and tangential (17b, 19b–19d) sections through foraminifera from Hedbergellidae family (superfamily Globigerinoidea; family range from Lower Cretaceous to Paleocene, BouDagher-Fadel 2013, p. 65–66); longitudinal (19a) and axial (20–23) sections through foraminifera from *Heterohelix* Ehrenberg genus (family Heterohelicidae, superfamily Heterohelicoidea; genus range from Late Albian to Maastrichtian, BouDagher-Fadel 2013, p. 70–71); transversal (24–26), tangential (27) and axial (28–29) sections through foraminifera from *Morozovella* McGowran genus (family Truncorotaloididae, superfamily Truncorotaloidinoidea; genus range Paleocene to Eocene, BouDagher-Fadel 2013, p. 151–152); micro photos 1–21, 24–29 – scales are 100 µm; micro photos 22–23 – scales are 20 µm; XPL – cross-polarized light; PPL – plane-polarized light; photos by Al. Ciornei (2013–2014).