

ANNEX C.
FLINT AND CHERT TYPES FROM KHOTYN AREA (CHERNIVTSI OBLAST, UKRAINE)

1. STUDY AREA AND GEOLOGICAL CONTEXT

The focus of this study are the origin control samples derived from two archaeological sites¹ (35 km apart) from Khotyn area (Middle Dniester Valley, Chernivtsi Oblast, Western Ukraine).

From a physiographic point of view, the area covered by the origin sites corresponds to a section of the Podolian Upland, while from a tectonic point of view, it overlaps the Eastern-European Platform. The area covered by the origin sites is an extension of the MidDn research perimeter (Annex B). The landscape is dominated by the Miocene sedimentary suites, but Cenomanian deposits (shallow-water marine sediments) outcrop along the Middle Dniester Valley and its northern tributaries (Pl. C1/1). The Cenomanian is represented by siliceous-tripoliform deposits, sandy-siliceous deposits, sandstones, and loose siliceous rocks (Siplivy *et alii* 1974, p. 26–28). In an older Romanian geological account for this area, the Cenomanian from Ocna-Onut-Poiana/Polyana area (West of Khotyn) is represented by coarse greenish sandstones (sometimes conglomeratic) with flint nodules, while at Gordeuți (current Hordivtsi), the Cenomanian is represented by sandstones with flint concretions (Macovei, Atanasiu 1930, p. 172–173).

Origin site	Elevation (m)	GPS coordinates		Context		Rock types	Samples	
		(Lat. N)	(Long. E)				MA	MiA
Oselivka-Chisla Nedjimova*	-	48.43889	26.59131	knapped lithics	Late Epigravettian, Upper Palaeolithic	Volhyno-Podolian flint, similar to Prut flint type FB, Dniester chert	40	6
Molodova**	-	48.55337	27.07891	knapped lithics	Gorodsk culture, Late Eneolithic	Dniester chert	6	1
							46	7
MA – number of samples in the macroscopic analysis; MiA – number of samples in microscopic analysis.								
* Oselivka-Chisla Nedjimova was discovered by M. Ceslav Ambrojevici in 1923 (Moroșan 1933, p. 16–17; Moroșan 1938, p. 106; Nicolăescu-Plopșor 1938, p. 54). The site is located on the Middle Dniester Valley, near Oselivka village, 12 km SE from Khotyn, then in Hotin County, Romania, now in Chernivtsi Oblast, Ukraine. The lithics discovered by Ambrojevici were initially framed as Micoquian and Aurignacian, while later accounts (Păunescu 1999, p. 43) considered them as Final Gravettian (=Epigravettian in current terminology) based on techno-typological similarities with the Dorohoi-Stracova assemblages (Botoșani County, Romania).								
** M. Ceslav Ambrojevici mentions a neolithic findspot at Molodova discovered in 1915 (Ambrojevici 1933; Moroșan 1929). However, the exact location of this findspot is unknown and the GPS coordinates indicate a general position around Bratanivka village (Chernivtsi Oblast, Ukraine). Amongst the finds there were flint axes specific to Gorodsk culture (Late Eneolithic). Apparently, Molodova is one of the locations (together with Restev-Atachi, Naslavcea and many other in the Kamianets-Podilskyi area) where workshops for axes of dull whitish flint, assigned to this culture, were discovered (Păunescu 1970, p. 63; Spinei 1971, p. 98; Boghian 1995, p. 10).								

Table C1. Origin sites from the MidDn research perimeter (Chernivtsi Oblast, Western Ukraine).

2. PETROGRAPHIC CHARACTERISATION OF THE FLINT AND CHERT FROM THE STUDY AREA

The petrographic data regarding the archaeological samples (Tab. C1; Pl. C1) was acquired in: a) 2017–2018, during a pilot study regarding the presence of long-distance raw materials in Upper Palaeolithic sites from Romania; b) 2023–2025, for comparison with geological samples from the Prut Valley.

In 2018, the petrographic data was obtained on: 40 samples from Oselivka – *Chisla Nedjimova* taken from a lithic assemblage representing all reduction stages with abundant cortical pieces and various tools; 6 samples from Molodova taken from a lithic assemblage representing the manufacture debris from Eneolithic flint axes. Both lithic assemblages are part of the N. N. Moroșan collection stored in the Palaeolithic deposit at the “Vasile Pârvan” Institute of Archaeology in Bucharest. The microscopic analysis from 2018 was conducted only on thin sections: six from Oselivka (published in Ciornei, Mariș 2020, p. 43–47), and one from Molodova derived from a legacy collection (Ciornei 2023, p. 33–36), but not published at that time of the pilot study. Not much is known about the context of the Molodova thin section other than it was originally extracted by Al. Păunescu from the N.N. Moroșan collection and that a brief bulletin of petrographic analysis was published a long time ago (Păunescu 1970, p. 225–226).

¹ The origin sites are not assumed to be the actual source of the compared raw materials, but rather a proxy (a general location) for their possible provenience when confirmed for a given site.

In 2023–2025, the samples were re-assessed in light of the petrographic data obtained on geological samples from the Middle Prut and Middle Dniester valleys. Hence the thin section witnesses were analysed in reflected light (under a Nikon SMZ 800N trinocular stereomicroscope with magnifications ranging from 10× to 160×) and the thin sections were analysed in transmitted light (under a Nikon Eclipse E200 Pol trinocular microscope with magnifications ranging from 40× to 400×). Photomicrographs of the thin sections and unprepared samples were taken with a Nikon D5600 DSLR camera mounted on the above-mentioned microscopes. The petrographic analyses from 2023–2025 were conducted in the Petroarchaeology Laboratory of the “Vasile Pârvan” Institute of Archaeology in Bucharest.

2.1. FLINT AND CHERT TYPES FROM OSELIVAKA

Based on macroscopic and microscopic traits, five Cretaceous flint and chert types (Tab. C2; Pls. C2/1–5, C3–C6) were differentiated for Oselivka – *Chisla Nedjimova*:

Volhyno-Podolian bioclastic flint² – siliceous material with a variable macroscopic appearance (Pl. C2/1) from dull whitish/whitish-blueish patina with a smoky-blueish band under the cortex (in fresh surface it is smoky, very translucent, or medium grey with a smoky subcortical area) to dull whitish/whitish-brownish patina (in fresh surface it is yellowish-brown, very translucent); the cortical areas are either very smoothened and thin chalky surfaces or neocortex (siliceous surfaces with abundant impact-point scars from water transport); microscopically it can be described as a bioclastic wackestone (fine to medium sand, moderately sorted) with siliceous groundmass (Pl. C3); particles (25–45%) are represented by bioclasts (bivalves, algae, echinoderms, molluscs), benthic foraminifera, planktonic foraminifera (*Globotruncanidae*, *Heterohelix*), and *Pithonella*; in the subcortical area the particle abundance is around 15–20% (Pl. C3); in pockets, *Pithonella* appears in flood abundance (40–50%) with small amounts of bioclasts and planktonic foraminifera;

Volhyno-Podolian pithonellid-bioclastic flint – siliceous material with dull whitish/grey-whitish patina (in fresh surface it is medium grey of brownish semi-translucent), very smoothened chalky cortex (Pl. C2/2); microscopically it can be described as a pithonellid-bioclastic packed wackestone (very fine sand, well sorted) with siliceous groundmass (Pl. C4); particles (40–50%) are represented by *Pithonella*, bioclasts (bivalves, algae, echinoderms, molluscs), planktonic foraminifera (*Globotruncanidae*, *Heterohelix*), and benthic foraminifera;

Volhyno-Podolian striped flint – siliceous material with a concentrically striped/veined appearance (Pl. C2/3); the samples from Oselivka were not microscopically analysed³;

Similar to Prut flint type FB – siliceous material with darker grey-blueish patina (in fresh surface it has a blackish colour, semi-opaque) and fresh-like chalky cortex (Pl. C2/4); microscopically it can be described by the same bioclastic-phytoplanktonic microfacies associated with Prut flint type FB (Pl. C5);

Dniester detrital-rich spiculitic chert – siliceous material with darker grey-blueish patina (in fresh surface it has a dark grey colour, semi-translucent), medium-grained; fresh-like granulated limestone cortex (Pl. C2/5); microscopically it can be described as a detrital-rich bioclastic-intraclastic packstone (medium sand, moderately-poorly sorted) with cryptocrystalline silica cement (Pl. C6); particles are represented by bioclasts (40%, mostly sponge spicules, but also algae, echinoderms, bivalves), benthic foraminifera, intraclasts (15%) and detrital quartz (10–15%).

2.2. CHERT TYPES FROM MOLODOVA

Based on macroscopic and microscopic traits, one Cretaceous chert type (Tab. C2; Pls. C2/6, C7) was differentiated for Molodova:

Dniester bioclastic-intraclastic chert – siliceous material with dull milky-white colour (semi-opaque) and medium grey translucent patches, fine-grained and rough appearance, with a fresh-like granulated limestone cortex (Pl. C2/6); microscopically it can be described as a bioclastic-intraclastic packed wackestone to packstone (fine sand, moderately-well sorted) with microquartz and chalcedony intergranular cements (Pl. C7); it is composed of bioclasts (sponge

² This characterisation and classification of the Volhyno-Podolian flint is based on the results obtained during the petrographic analysis of: 1) 85 geological samples from 19 locations in Rivne-Dubno area (Rivne Oblasts, Western Ukraine) derived from the field surveys carried in 2018–2020 by a team lead by A. Maier, V. Chabai, and P. Vasyliev; 2) two geological samples from two locations in Ternopil area (Ternopil Oblast, Western Ukraine) collected in 2013 by M. Brandl during surveys for locating the Habsburg gunflint workshops; 3) 21 origin control samples from the Habsburg gunflint manufactory at Nyzhniv/Nizniow in Dubivitsi area (Ivano-Frankivsk Oblast, Western Ukraine) collected in 2009 by M. Brandl during surveys for locating the Habsburg gunflint workshops. This petrographic analysis was conducted in July 2024 at the Petroarchaeology Laboratory of the “Vasile Pârvan” Institute of Archaeology in Bucharest. The results of this analysis are presented in a different study (Ciornei *et alii*, in preparation).

³ Under the microscope, this material has a similar composition to the bioclastic type: it is composed of smoky-dark grey bands of bioclastic wackestone (15–20% particles) or medium grey/beige bands (with 25–45% particles) alternating with light grey/grey bands of pithonellid packed wackestone with *Pithonella* in flood abundance and minor bioclasts and planktonic foraminifera (Ciornei *et alii*, in preparation).

spicules, algae, echinoderms), benthic foraminifera, planktonic foraminifera (indicating the Upper Cretaceous), calcispheres, intraclasts, and detrital quartz.

Rock categories and subcategories	Origin sites				Oselivka				Molodova			
	MA	MiA	Stm	Pol	MA	MiA	Stm	Pol	MA	MiA	Stm	Pol
Volhyno-Podolian bioclastic flint	13	3	4	3	13	3	4	3	0	0	0	0
Volhyno-Podolian pithonellid-bioclastic flint	9	1	2	1	9	1	2	1	0	0	0	0
Volhyno-Podolian striped flint	2	0	0	0	2	0	0	0	0	0	0	0
similar to Prut flint type FB	6	1	2	1	6	1	2	1	0	0	0	0
Dniester detrital-rich spiculitic chert	10	1	1	1	10	1	1	1	0	0	0	0
Dniester bioclastic-intraclastic chert	6	1	2	1	0	0	0	0	6	1	2	1
	46	7	11	7	40	6	9	6	6	1	2	1

MA – number of samples in the macroscopic analysis; MiA – number of samples in microscopic analysis; Stm – number of subsamples analysed with a stereomicroscope; Pol – number of subsamples (thin sections) analysed with a polarizing microscope.

Table C2. Types of flint and chert from the MidDn research perimeter (Chernivtsi Oblast, Western Ukraine).

3. OCCURRENCE, ABUNDANCE AND AVAILABILITY

The artefacts from Oselivka are patinated and thus the initial macroscopic grouping reflected differences in patination traits, which were validated by the microscopic analysis of thin sections (2018). The recent microscopic analysis confirmed that there are two types of Volhyno-Podolian flint, one “similar to Prut flint type FB”, and one type of Dniester chert. The Volhyno-Podolian striped flint was confirmed only macroscopically.

The main characteristic of the Volhyno-Podolian flint is the association of bivalves and algae fragments, *Pithonella* and planktonic foraminifera. The petrographic traits of the Volhyno-Podolian flint as described here are in good agreement with the petrographic data (bivalve fragments, *Pithonella* in flood abundance and planktonic foraminifera) of the Upper Turonian chalks with ten regularly scattered flint layers (Dubicka, Peryt 2012, p. 200–202) from Dubivtsi quarry⁴ (near Dubivtsi village, Ivano-Frankivsk Oblast; Pl. C1).

When the cortex is considered, the Volhyno-Podolian flint is in stark contrast with the materials identified as “similar to Prut flint type FB” and Dniester detrital-rich spiculitic chert from Oselivka, both of which have “fresher” chalk/limestone cortex (Pl. C2). This means that the Volhyno-Podolian flint from Oselivka does not have primary outcrops (chalk or eluvium) in the vicinity of the site and most probably was transported by waters from somewhere else. The closest Turonian chalks with flint are outcropping around Dubivtsi (Ivano-Frankivsk Oblast), some 125 to 150 km NW from Oselivka (Pl. C1). The geological data indicates that Turonian deposits with flint are not outcropping in Khotyn area (Siplivy *et alii* 1974, p. 28–29), but the possibility that Volhyno-Podolian flint could be found in gravel deposits is confirmed by a similar case from further upstream the Dniester Valley. At the multilayered Upper Palaeolithic site of Doroshivtsi III, located 56 km WNW from Oselivka (Pl. C1), the main raw material is represented by fine-grained smoky to black Turonian flint that can be found in the modern and terrace alluvium (Kulakovska *et alii* 2015, p. 348).

The geological accounts for Khotyn area (Macovei, Atanasiu 1930, p. 172–173; Siplivy *et alii* 1974, p. 26–28; Konoplya 1998, p. 147–148) indicate the presence of nodular cherts associated with Cenomanian sandstone deposits. Dniester chert type GLG from Naslavcea occurs in an eluvium deposit as nodules and lenses associated with siliceous sandstone lenses with a sandy-siliceous matrix (Annex B). Given the presence at Oselivka of a material similar to Dniester chert type GDG, it can be inferred that at least part of the Cenomanian sequence from Naslavcea extends towards Khotyn area.

The geological context from Oselivka and Molodova is only known from bibliography, hence it is not clear if the material here called “similar to Prut flint type FB” has a local natural occurrence around Oselivka or it was brought to

⁴ According to historical accounts (Brandl 2013, p. 255–256; Brandl *et alii* 2018, p. 499), the raw material used for gunflint manufacture at Nizniow (Dubivtsi area, Ivano-Frankivsk Oblast) was a blackish-brown and grey high-quality flint occurring in five distinct layers in a white chalk-like limestone. This raw material was directly exploited around Nizniow and its hinterland (Lichostiwno Hill), but also brought from Mariampol (Maryampil) on the Dniester some 20 km NW from Nizniow. This gunflint workshop is located 28 km SE from Dubivtsi quarry on the Upper Dniester Valley. The blackish variety of nodular flint used at Nizniow and occurring between the rivers Dniester and Zbruch was named “Podolian flint” in the 18th century by Balthasar Hacquet de la Motte (Brandl 2013, p. 158–159, 161; Brandl *et alii* 2018, p. 498). The predominant raw material used in the Neolithic Tripolye culture was described as “Volhynia flint” of Turonian age, a very fine grained and homogenous material of transparent smoky colour with grey opaque patches (Petrougne 1995, p. 191–192). The Turonian flint of Western Ukraine was separated based on geographical occurrence in: Wester Volhynian flint and Podolian flint (Konoplya 1998, p. 148–155).

the site by Upper Palaeolithic human groups⁵. The meagre geological accounts offer no direct support for the first supposition, while the second supposition cannot be corroborated by current archaeological evidence on raw material exploitation.

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List of tables and plates

Table C1. Origin sites from the MidDn research perimeter (Chernivtsi Oblast, Western Ukraine).

Table C2. Types of flint and chert from the MidDn research perimeter (Chernivtsi Oblast, Western Ukraine).

Plate C1. Distribution map of origin sites from the MidDn research perimeter (Chernivtsi Oblast, Western Ukraine) and geological locations from the Middle Prut Valley (Botoșani County, Romania) and Middle Dniester Valley (Ocnița District, Republic of Moldova); **Inset 1.1.** Origin sites (Oselivka-Chisla Nedjimova and Molodova) and their geological contexts: K₁₋₂ - Cretaceous deposits (sandstones, argillites, marls); K_{2s} - Cenomanian deposits (glauconite sands with phosphorite concretions, marls, tripoli, sandstones, spongolites, limestones); Map created in QGIS (projection is latitude-longitude WGS-84).

Plate C2. Macroscopic views of archaeological samples from Oselivka-Chisla Nedjimova (1–5) and Molodova (6): 1. Volhyno-Podolian bioclastic flint; 2. Volhyno-Podolian pithonellid-bioclastic flint; 3. Volhyno-Podolian striped flint; 4. Similar to Prut flint type FB; 5. Dniester detrital-rich spiculitic chert; 6. Dniester bioclastic-intraclastic chert; all scale bars are 2.5 cm long (photographs by Al. Ciornei 2017–2018).

Plate C3. Photomicrographs of Volhyno-Podolian bioclastic flint from Oselivka-Chisla Nedjimova (Chernivtsi Oblast, Ukraine); 1–2, 5–7 - views of water immersed samples; 3–4, 8 - views of thin sections; RL - reflected light; PPL - plane polarized light; XPL - cross polarized light (photographs by Al. Ciornei 2023–2025).

Plate C4. Photomicrographs of Volhyno-Podolian pithonellid-bioclastic flint from Oselivka-Chisla Nedjimova (Chernivtsi Oblast, Ukraine); 1–2, 5–7 - views of water immersed samples; 3–4, 8 - views of thin sections; RL - reflected light; PPL - plane polarized light; XPL - cross polarized light (photographs by Al. Ciornei 2023–2025).

⁵ Konoplya (1998, p. 146–147) describes a black (less commonly light or dark grey) flint associated with the Upper Cenomanian limestone sequence of the Middle Dniester region. The flint is composed of skeletal fragments of siliceous sponges.

Plate C5. Photomicrographs of similar to Prut flint type FB from Oselivka-*Chisla Nedjimova* (Chernivtsi Oblast, Ukraine); 1–2, 5–7 - views of water immersed samples; 3–4, 8 - views of thin sections; RL - reflected light; PPL - plane polarized light; XPL - cross polarized light (photographs by Al. Ciornei 2023–2025).

Plate C6. Photomicrographs of Dniester detrital-rich spiculitic chert from Oselivka-*Chisla Nedjimova* (Chernivtsi Oblast, Ukraine); 1-2, 6-7 - views of water immersed samples; 3–5, 8 - views of thin sections; RL - reflected light; PPL - plane polarized light; XPL - cross polarized light (photographs by Al. Ciornei 2023–2025).

Plate C7. Photomicrographs of Dniester bioclastic-intraclastic chert from Molodova (Chernivtsi Oblast, Ukraine); 1–2, 6–7 - views of water immersed samples; 3–5, 8 - views of thin sections; RL - reflected light; PPL - plane polarized light; XPL - cross polarized light (photographs by Al. Ciornei 2023–2025).