

# Lithic production and the use of siliceous raw material in the Neolithic of Istria, Croatia – a case study from Kargadur and Vižula

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**ABSTRACT** - *This article contains the results of the lithic analysis of assemblages from the Neolithic sites of Kargadur and Vižula in southern Istria, Croatia. The assemblages have been analysed in terms of reduction strategies and typology, with a special focus on raw material analysis and petrographic analysis. During the Early Neolithic, and especially the Middle Neolithic, raw materials circulated the Istrian peninsula, as evidenced by the presence of obsidian and other non-local (exogenous) chert at several sites. Obsidian is certainly an exotic material in this region, and items found at Kargadur come from the Aeolian islands. With these results we have tried to gain a better understanding of lithic production of the period, the approach of the Neolithic people to raw materials and the scope of the distribution network of high-quality chert.*

**KEY WORDS** – *Early Neolithic; Middle Neolithic; lithic analysis; Istria; Croatia*

## **Litična produkcija in uporaba silikatne surovine v neolitiku Istre na Hrvaškem – študija primera iz Kargadurja in Vižule**

**IZVLEČEK** – *V članku predstavljamo rezultate analize litičnih zbirov z neolitskih najdišč Kargadur in Vižula v južni Istri na Hrvaškem. Analize zbirov so bile usmerjene v strategije redukcij in tipologije, s posebnim poudarkom na analizi surovin in petrografski analizi. Prisotnost obsidiana in drugih nelo-kalnih (eksogenih) rožencev na več najdiščih dokazuje kroženje surovin po istrskem polotoku v zgodnjem in zlasti srednjem neolitiku. Obsidian je v tej regiji zagotovo eksotičen material in predmeti, najdeni v Kargadurju, prihajajo z Eolskih otokov. S pomočjo teh rezultatov skušamo bolje razumeti neolitsko proizvodnjo, dostop do surovin in obseg distribucijske mreže visokokakovostnega roženca.*

**KLJUČNE BESEDE** – *zgodnji neolitik, srednji neolitik; litična analiza; Istra; Hrvaška*

## **Introduction**

The part lithic industries played in the everyday life of the Neolithic people has only recently come into the focus of archaeologists. The Early Neolithic in the Eastern Adriatic is associated with the Impressed Ware culture that dates to c. 6000–5400 cal BC, and it seems there is ample evidence of cultural uniformity of Dal-

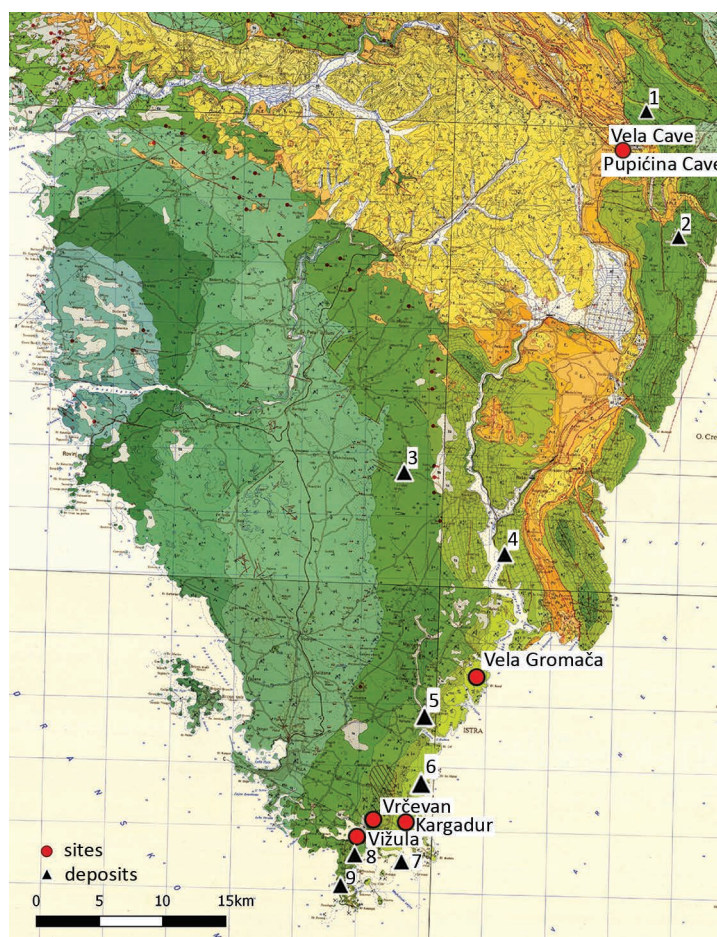
matian and Apulian Impressed Ware. The almost exclusive reliance of Dalmatian Neolithic sites on the exogenous chert from the Gargano promontory during the Early Neolithic also testifies to the socio-economic relationship of the two Adriatic coasts (Kačar 2019b), and to the seafaring abilities of the Early Neolithic peo-

ple which contributed greatly to the spread of impressed pottery (Forenbaher, *Miracle* 2006:514). The authors Forenbaher and Miracle proposed a model of Neolithisation of the Eastern Adriatic coast that took place in two phases. The first phase constituted a rapid ‘pioneer exploration’ associated with the typical impressed ware and limited to the southern Adriatic. The second phase was a slower one and it was composed of ‘slow agropastoral expansion’. This is when the whole ‘Neolithic package’, including farming, herding and impressed pottery, was assembled and introduced to the Istrian peninsula *c.* 5750 BC. Later, there was a continuation of the ‘agropastoral expansion’ into the Northern Adriatic associated with Danilo-Vlaška pottery of the Middle Neolithic, *c.* 5600 BC (*O.c.* 516). John Chapman *et al.* (1996) and Paolo Biagi and Elisabetta Starnini (1999) also support the migrationist view and emphasize the rarity of Late Mesolithic occupation in the region, and an abrupt shift from wild to domestic animals at the Mesolithic-Neolithic transition (Forenbaher, *Miracle* 2006).

Another theory suggests different Neolithization scenarios for Dalmatia and Istria on account of differences in lithic production, settlement patterns and subsistence strategies (Kačar 2021:807). The transition to farming in Dalmatia and Apulia was relatively rapid as a result of the colonization of the open landscape linked to the 8.2 ka event. The settlers based their subsistence almost exclusively on agriculture and livestock and their lithic blade production was based on exogenous Gargano chert. On the other hand, in the north of the Adriatic basin (Istria, Karst, Po Plain and Marches) the Neolithic emerged later, possibly as a result of acculturation. Mesolithic groups of hunter-fisher-gatherers may have played an active role in the Neolithisation process in these areas, which can be seen in some Castelnovian traditions identified in the lithic production of Neolithic sites dated to the Impressed Ware period: the use of local cherts, lamellar production by indirect percussion, and simpler forms of pressure flaking. Fishing as a subsistence strategy also remained an important food source (*O.c.* 810). A theory of Neolithisation by Ruth Tringham (1971) also suggested a continuity of economic practices and lithic use from the Mesolithic to Early Neolithic. Mihael Bu-

dja (1993; 1996; 1999) presented a theory that rejected migration as a driving force of Neolithisation and suggested the acceptance of a limited number of innovations by the autochthonous population.

In this paper, we will present the results of the lithic analysis of assemblages from two Neolithic sites in southern Istria, Croatia – Kargadur and Vižula (Fig. 1) – which was done as a part of the author’s doctoral thesis (Šprem 2022). Kargadur is an Early and Middle Neolithic site situated around two kilometres south-east from the town of Ližnjan in Kuje Bay. The first excavations started in 2002 (Komšo 2005; 2006a; 2006b). The remains of terrestrial and marine animals, pottery and stone tools have been recorded at the site in the Early Neolithic horizon, while analyses of palaeobotanic remains have shown that the inhabitants of the settlement grew barley, wheat, legumes and spelt (Komšo 2006a:235). Four bone hooks and several



**Fig. 1.** Map of the Croatian part of the Istrian peninsula and the sites mentioned in the text. 1 chert deposits on Čičarija Mt, 2 chert deposits on Učka Mt, 3 Poljaki, 4 Trget, 5 Budava Bay, 6 Kala Bay, 7 Marlera, 8 Vižula, 9 Polje Bay (after Šprem 2023). Geological map after Pleničar *et al.* 1969; Šikić *et al.* 1969; 1972; Polšak, Šikić 1973; Polšak 1967; Magaš 1968.

bone semi-finished products testify to the fishing tradition of the settlement, and represent a unique find from the Early Neolithic period in the eastern Adriatic coast. The first phase of the settlement is radiocarbon dated to  $6760 \pm 60$  BP; 5710–5630 cal BC (Beta – 188924, *Komšo 2006b.113*). After the Early Neolithic phase and a hiatus, a settlement was re-formed on Kargadur in the Middle Neolithic period. One of the main differences in settlements is the presence of cattle. Twenty-five (25) obsidian fragments testify to a branched economic network during the Middle Neolithic. The prismatic blades made of high-quality chert of exogenous origin also stand out (*Komšo 2006a.235*).

The Early Neolithic site of Vižula is located about 3.5 kilometres west of Kargadur (Fig. 1). It is a small circular peninsula near today's settlement of Medulin. The Neolithic site was discovered in 1969, when the first test trench was opened (*Bačić 1969*). The site was later excavated between 1972 and 1974 (*Codacci 2002.151*). The Early Neolithic layer 20cm thick lay on the bedrock at a depth of 40cm from the present surface (*Bačić 1969.23*). Several hearths and pits were found, along with pottery fragments with impresso decoration, daub fragments and several thousand chipped stone artefacts. Boris Bačić (*1969.24*) pointed out that the Early Neolithic layer was found undisturbed, *i.e. in situ*. A radiocarbon date for the Neolithic layer is available:  $6850 \pm 180$ ; 6100–5450 cal BC (HD-12093) (*Chapman, Müller 1990.130; Andreasen 2009.56*). The daub fragments indicate the existence of houses, while a large amount of chipped stone artefacts

with cortex show that the activities related to the extraction and initial processing of chert may have happened on site (*Spataro 2002.43–44*), since the small peninsula contains layers of coarse-grained chert in primary deposition, as well as beach pebbles, on its southeastern side. Animal bones and a large number of shells were also found at the site, most often *Cardium edule*, *Lamarcki* and oysters. Little is known about the species of animals represented, except that most of them are ovicaprids. It seems that the survival strategy of the inhabitants of Vižula consisted of hunting, fishing, and agriculture (*O.c.44*).

### Materials and methods

This study is based on the lithic analysis of assemblages from the Neolithic sites of Kargadur and Vižula. The lithic artefacts were analysed according to technological and typological aspects, with a special focus on the raw material analysis, as a part of which micropetrographic analysis on finds from Kargadur was done.

The Kargadur assemblage consists of 1482 artefacts found in trench 3 investigated in 2005 and 2006. Lithic material from the site is divided into horizons of the Early and Middle Neolithic, and into mixed horizon (horizon A) (*Komšo 2005.213*). Horizon A is formed by recent layers with a smaller number of cultural finds in secondary deposition, in which 691 lithic artefacts were found. The Early Neolithic assemblage we analysed consists of 216 artefacts, while 1266 analysed artefacts come from the Middle Neolithic horizons. Unattributed artefacts, a total of 199 of them, were exempt from this analysis. We will also not be discussing the results of the analysis of the mixed (A) horizon, which makes the total number of analysed artefacts 1482.

The Early Neolithic assemblage from Vižula consists of 2834 lithic artefacts. Part of the material comes from the excavations of the site, while several pieces were collected “from the soil layer on the southern coast of Vižula”. Several pieces were extracted “from the layer of red soil from the southeast coast”, and several pieces were collected “from the shore on the isthmus where Ro-

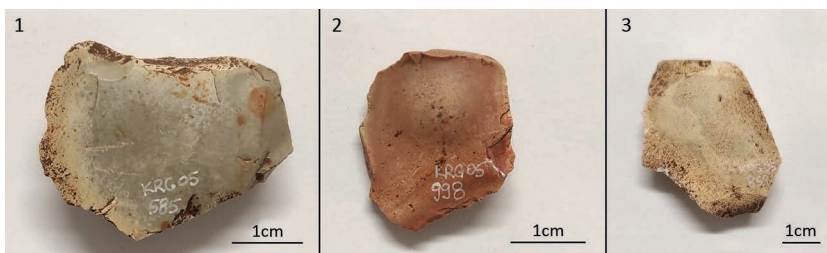


Fig. 2. Lithic finds from Kargadur attributed to Vižula chert.

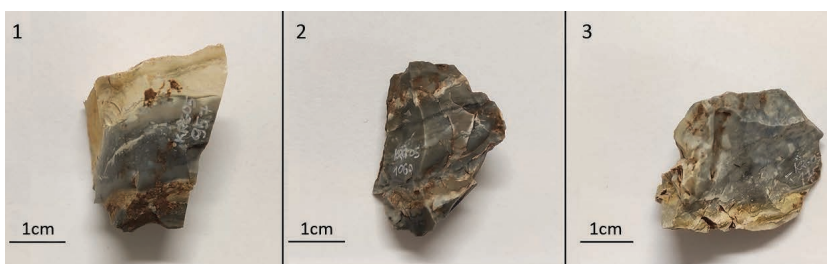


Fig. 3. Lithic finds from Kargadur attributed to Marlera chert.

*man tombs are*".<sup>1</sup> Several pieces were found in an uncertain context along with Roman pottery or black and white tesserae. Some of the material did not have information on the context of the findings. Moreover, due to the unfavourable situation with the COVID-19 pandemic and the relocation of the Archaeological Museum of Istria in Pula, we were not able to complete the analysis of the entire material. Moreover, we cannot say what proportion of the lithic material found at Vižula our sample represents. Given all the above, as well as the lack of detailed documentation kept during the excavation, this lithic material represents a randomly selected sample of artefacts from the site.

The lithic analysis of 416 pieces from Vižula, with an emphasis on typological analysis, was conducted by Giulia Codacci (2002). She also conducted a raw material analysis which showed that 91.75% of the products were made from local raw materials from Vižula marked as 'st 1', while 4.37% of the products were made from the subtype of local raw materials marked as 'st 2'. The third type of raw material, marked as 'st 3', is a dark grey-brown chert of better quality represented in 2.91% of the products. About 0.73% of the analysed products were made of white chert, probably of exogenous origin and marked as 'st 4'. Products made of limestone pebbles are represented by 0.96% of the sample (O.c.159–161). We conducted our analysis independently of Codacci's results.

### Technological analysis

Technological analysis is a discipline that enables the reconstruction of the methods and techniques of making artefacts. The originator of technological analysis was André Leroi-Gourhan, who devised the concept of a *chaîne opératoire* (Inizan et al. 1999.14–16). Therefore, the chain of operations represents a kind of chronological scale of production of artefacts composed of different phases and categories (Blaser et al. 1999–2000.367). For our analysis, we adapted the list of the technological categories used by Rajna Šošić Klindžić (2010.67–73) in her work on the Early Neolithic communities in Northern Cro-

atia. These are: pebble or nodule, preform, cortical flake, cortical blade, bladelike flake, flake, blade, flake from retouching, core, crested blade, platform renewal flake, core tablet, overshot blade, debris, miscellaneous.

### Typological analysis

For the purposes of typological analysis, another adapted list based on the work of Klindžić (O.c. 74–76) was used. These documented tools are: the retouched piece, end-scraper, side-scraper, burin, perforator, truncated piece, double truncated piece, geometric piece, notched piece, denticulate, point.

### Raw material analysis

For the purposes of raw material analysis, the lithic assemblages from Kargadur and Vižula were examined according to visual characteristics using a hand lens (10x magnification). The following variables of the artefacts were taken into account: colour, particles in the texture, structure, gloss, translucency. Based on these characteristics and based on the samples collected from our reference collection of chert deposits in Istria, the artefacts were divided into several categories of raw materials depending on their deposit of origin.



Fig. 4. Lithic finds from Kargadur attributed to Marlera chert, fourth and fifth sample.



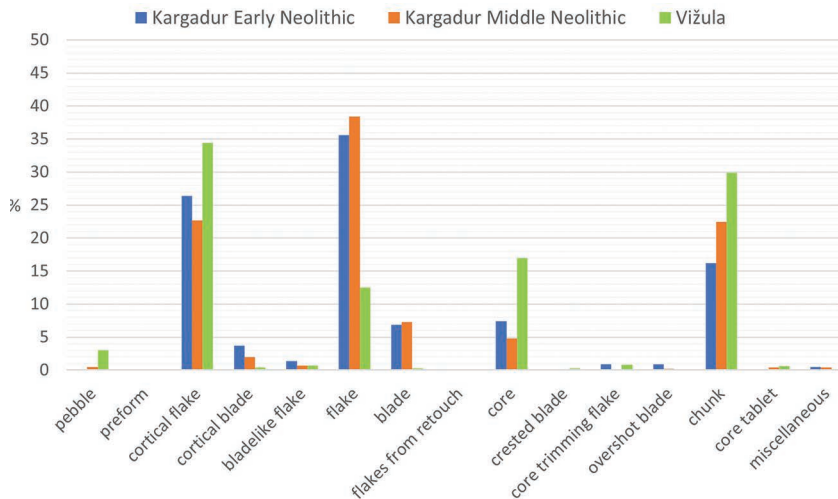
Fig. 5. Lithic finds from Kargadur attributed to local raw material of unknown deposit.

1 Information from the field documentation of the Archaeological Museum in Pula, Croatia.

Since this analysis deals with provenance and distribution networks of raw material, we mostly focused on whether the raw material is local (a day's walk from the site, or 30 kilometres) or exogenous (from deposits located outside the peninsula, located more than a day's walk away, or more than 30 kilometres). Artefacts showing 'craters' and fissures as a result of being exposed to heat were also recorded and placed in the 'burned' category. The category 'indeterminate' was used in situations where, for example, the patina covered the entire surface of the piece so the raw material could not be determined. Each site has its own list of raw materials, which was formed on the spot as the analysis of materials took place. The lists were then compared for the final result.

### Petrographic analysis

A micropetrographic analysis was done on lithic finds from Kargadur made from local raw materials since the focus of our doctoral research was the usage of local chert during prehistory and this paper relies mostly on said research (Šprem 2022). We decided on three samples of raw material macroscopically identified as Vižula chert (Fig. 2), five samples of raw material



**Fig. 6.** Chart showing the percentage of technological categories in the analysed assemblages from Kargadur and Vižula.

identified as Marlera chert (Figs. 3 and 4) and two samples of local raw material whose deposit of origin is unknown (Fig. 5). The micropetrographic samples are made by grinding them to a thickness of 30 µm. The analysis was performed on a binocular polarising microscope Radical, model RPL-3B.

### Results

#### Technological analysis

Among the flint artefacts from the Early and Middle Neolithic horizon at Kargadur, flakes predominate (Figs. 6 and 7). Blades and cortical blades are less common. Cores are more frequent in the Early Neolithic assemblage. There is a high proportion of cortical flakes in both horizons. We recorded one crested blade and five overshot blades, which suggests some blade cores were reduced at the site. Since flakes are the most dominant category, this suggests they were the main goal of the reduction process. The presence of cores with cortex, along with cortical flakes, indicates that the raw material was brought to the site and the production process started there.

Cortical flakes are dominant on Vižula (Figs. 6 and 7). They are followed by debris, which is represented by almost one third of all analysed pieces. This should not be surprising considering the cracking of Vi-

| Technological category | Kargadur Early Neolithic |              | Kargadur Middle Neolithic |              | Vižula Early Neolithic |              |
|------------------------|--------------------------|--------------|---------------------------|--------------|------------------------|--------------|
|                        | n                        | %            | n                         | %            | n                      | %            |
| pebble                 | 0                        | 0            | 6                         | 0,5          | 84                     | 3,0          |
| preform                | 0                        | 0            | 0                         | 0            | 0                      | 0            |
| cortical flake         | 57                       | 26,4         | 287                       | 22,7         | 975                    | 34,4         |
| cortical blade         | 8                        | 3,7          | 25                        | 2,0          | 10                     | 0,4          |
| bladeliike flake       | 3                        | 1,4          | 9                         | 0,7          | 21                     | 0,7          |
| flake                  | 77                       | 35,6         | 486                       | 38,4         | 354                    | 12,5         |
| blade                  | 15                       | 6,9          | 92                        | 7,3          | 9                      | 0,3          |
| flakes from retouch    | 0                        | 0            | 0                         | 0            | 0                      | 0            |
| core                   | 16                       | 7,4          | 61                        | 4,8          | 481                    | 17,0         |
| crested blade          | 0                        | 0            | 1                         | 0,1          | 9                      | 0,3          |
| core trimming flake    | 2                        | 0,9          | 1                         | 0,1          | 23                     | 0,8          |
| overshot blade         | 2                        | 0,9          | 3                         | 0,2          | 2                      | 0,1          |
| chunk                  | 35                       | 16,2         | 285                       | 22,5         | 848                    | 29,9         |
| core tablet            | 0                        | 0            | 5                         | 0,4          | 16                     | 0,6          |
| miscellaneous          | 1                        | 0,5          | 5                         | 0,4          | 2                      | 0,1          |
| <b>Total</b>           | <b>216</b>               | <b>100,0</b> | <b>1266</b>               | <b>100,0</b> | <b>2834</b>            | <b>100,0</b> |

**Fig. 7.** Table showing frequencies and percentages of technological categories in the analysed lithic assemblages from Kargadur and Vižula.

žula chert, the material which was used to the greatest extent at the site. Next in terms of representation are cores and core fragments, followed by flakes, which appear to have been the main goal of reduction strategies at the site. On the other hand, blades are represented by only nine pieces, all from local chert. The presence of nine crested and two overshoot blades, also from local chert, suggests that some of the blades were made on site. Pebbles or chunks of unused raw material are also present. We recorded cortex on 81.4% of finds. This can be explained by the fact that the source of raw material used to the greatest extent is located on the nearby southeast coast of the peninsula, about 500 meters away.

### Typological analysis

In the Early Neolithic horizon of Kargadur tools are represented by 8.3% of the artefacts, the most common being retouched pieces (Figs. 8 and 9). Most of the tools from the Early Neolithic horizon at Kargadur were made on flakes (66.7%), with an equal number made cortical flakes and blades (Fig. 10). In the Middle Neolithic horizon tools represent 10.2% of the assemblage, with retouched pieces being the most frequent. Points were also recorded, as well as burins and perforators. Most of them were made on flakes, but also cortical flakes and blades (Fig. 10). When it comes to raw material preference, Vižula chert was more popular for the production of tools during the Early Neolithic, while Marlera chert prevailed during the Middle Neolithic. There is a clear increase in the presence of exogenous chert during the Middle Neolithic, and therefore there are more tools made from it, too (Fig. 11).

Of the 2834 artefacts analysed from Vižula, only 94 pieces (3.3%) were retouched. The most common type of tool is a retouched piece followed by a notched piece (fig. 8 and 9). Scrapers and points are also present. Other tools are represented by less than 10% of the artefacts. Most of the tools from Vižula were made on cortical flakes, which makes a clear difference to the tools from Kargadur (Fig. 10). When it comes to raw materials, all of the tools

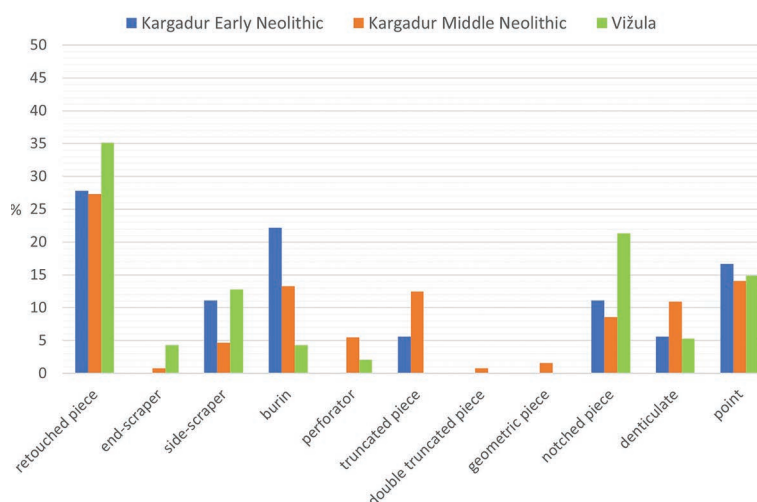


Fig. 8. Chart showing percentage of tool types.

from Vižula, except two retouched pieces from Marlera chert and one from chert of indeterminate origin, were made from Vižula chert (Fig. 11). We assume that the reason for this lies in the closeness of the Vižula deposit and the users' affinity for *ad hoc* tools in general. The three artefacts made from exogenous chert were not retouched.

### Raw material analysis

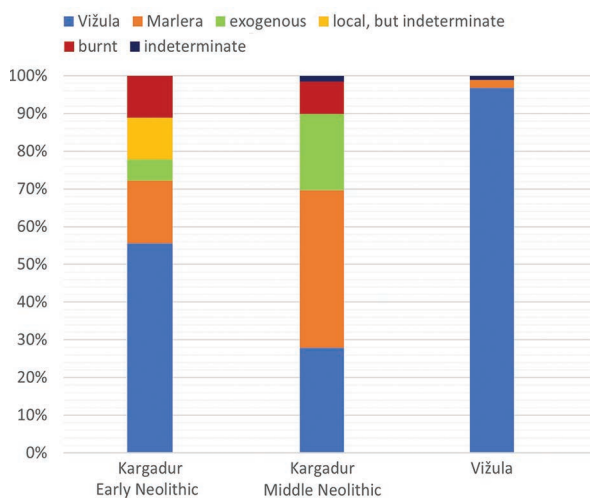
The material from the Kargadur site was divided into 11 categories of raw materials, described in more detail in Katarina Šprem (2022). For the purposes of the provenance analysis, we further grouped the raw materials into seven groups which we use here: Vižula deposit; Marlera deposit; exogenous raw material; local raw material, but the exact location is currently undetermined; burned; undetermined; and miscellaneous. We assume that some exogenous raw materials from Kargadur came from various formations in the area of the Monti Lessini mountains in northern Italy, such as the Maiolica formation, Scaglia Rossa formation,

| Tool type              | Kargadur Early Neolithic | Kargadur Middle Neolithic | Vižula Early Neolithic |
|------------------------|--------------------------|---------------------------|------------------------|
| retouched piece        | 5                        | 35                        | 33                     |
| end-scraper            | 0                        | 1                         | 4                      |
| side-scraper           | 2                        | 6                         | 12                     |
| burin                  | 4                        | 17                        | 4                      |
| perforator             | 0                        | 7                         | 2                      |
| truncated piece        | 1                        | 16                        | 0                      |
| double truncated piece | 0                        | 1                         | 0                      |
| geometric piece        | 0                        | 2                         | 0                      |
| notched piece          | 2                        | 11                        | 20                     |
| denticulate            | 1                        | 14                        | 5                      |
| point                  | 3                        | 18                        | 14                     |
| <b>Total</b>           | <b>18</b>                | <b>128</b>                | <b>94</b>              |

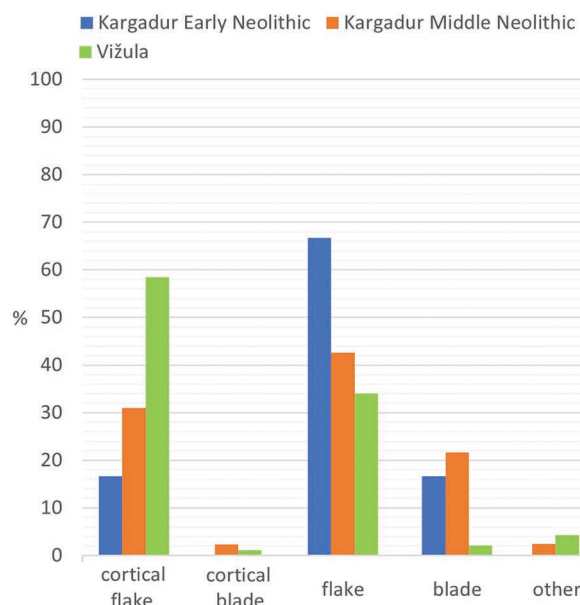
Fig. 9. Table showing frequency of tool types.

Scaglia Variegata formation and formation with Tertiary calcarenites (Fig. 26; see *Peresani et al. 2016.41*).

The analysis of the assemblage from Kargadur showed that during the Early Neolithic Vižula chert was dominant (Fig. 12), while during the Middle Neolithic raw materials from Marlera predominated (Fig. 14). During the Early Neolithic, local raw material from Vižula was mostly used to make blades, with a fifth of all blades being made from Marlera chert (Fig. 13). This situation changes during the Middle Neolithic when the percentage of exogenous raw material increases and Vižula chert decreases (by almost a half), with most of the blades now made from Marlera and exogenous chert (Fig. 15). Most of the local raw material was used to make flakes, however. This data takes into account only flakes and blades without cortex; cortical flakes and blades were not included since it is considered they do not represent the ultimate goal of reduction strategies (*Inizan et al. 1999*). Despite this, as many as 43 tools out of a total of 147 such items were made on cortical flakes (Fig. 10), which makes up almost a third of all tools. This was done to ensure the most economical use of raw materials (*Karavanić et al. 2008.38*). The difference lies in their approach to cortical blades. While cortical flakes were regularly retouched, only three cortical blades were retouched into tools. Our data also shows that the local raw material, like that from Vižula and Marlera, was brought to the site and decortified there during the Early and Middle Neolithic. There is a small number of cortical, crested and overshoot blades present in both horizons which leads us to conclude that some of the blades were made at the site. Cortical flakes, cortical and overshoot blades, as well as cores from exogenous chert,



**Fig. 11. Percentage of tools according to raw materials.**

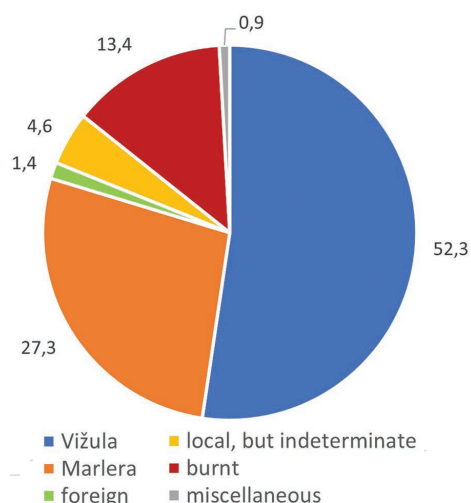


**Fig. 10. Percentage of tools according to the blank types.**

were recorded in the Middle Neolithic horizon, which suggests that the exogenous raw material was brought to site where the core preparations started and the production of blades was done.

It is also important to mention the obsidian fragments found in the Middle Neolithic layers, which come from the Aeolian Islands, by far the most popular source of obsidian for Neolithic settlements on the eastern Adriatic coast (*Tykot 2014.176-179*). Only two obsidian fragments found in Istria come from Carpathian sources (*O.c.178*). The presence of obsidian also testifies to a branched network of trade and exchange with one advantage: the source of obsidian can be determined geochemically very precisely, even between several deposits in one area (*O.c.174*), which makes research on the provenance and contacts between populations in prehistoric times easier. It is believed that Aeolian obsidian came to the Adriatic region by sea, bypassing southern Italy, but there is also a possibility of a land route from the Tyrrhenian Sea to the eastern coast of the Adriatic Sea (*O.c.178*). Aeolian obsidian is also present at the Neolithic sites of Danilo, Pokrovnik and Sušac, while several fragments of Carpathian obsidian were found at Danilo and Pokrovnik, and two obsidian fragments from Palmarola were found at Sušac (*O.c.178-179*).

The raw materials represented in the analysed set of artefacts from Vižula are mostly local, meaning the material comes from the peninsula itself (Fig. 16). There are 40 artefacts made from Marlera chert, three



**Fig. 12. Raw material present in the analysed assemblage from the Early Neolithic horizons of Kargadur.**

artefacts from exogenous chert and 80 artefacts could not be assigned a raw material category. Ten artefacts were made from limestone. The limestone can be explained by the nature of the Vižula raw material. This chert is silicified limestone, or diagenetic chert, with nodules silicified to a greater or lesser extent, and therefore the limestone must have come from the same deposit. The three artefacts made from exogenous raw materials are a core (radiolarite), a chunk and a flake (Fig. 17).

### **Micropetrographic analysis**

#### *Vižula chert*

Raw material from Vižula is usually described as greyish, sometimes yellowish chert (N8 to N5, very light grey to medium grey, sometimes 10R 8/2 moderate reddish brown or 10YR 2/2 dusky yellowish brown after Munsell, Šprem 2022.59). Our chosen samples

were determined as Vižula raw material by macroscopic analysis and comparison with the samples collected at the deposit. Micropetrographic analysis of the first sample showed cryptocrystalline chert with rare microfossil relics, interspersed with cryptocrystalline calcite (Fig. 18).

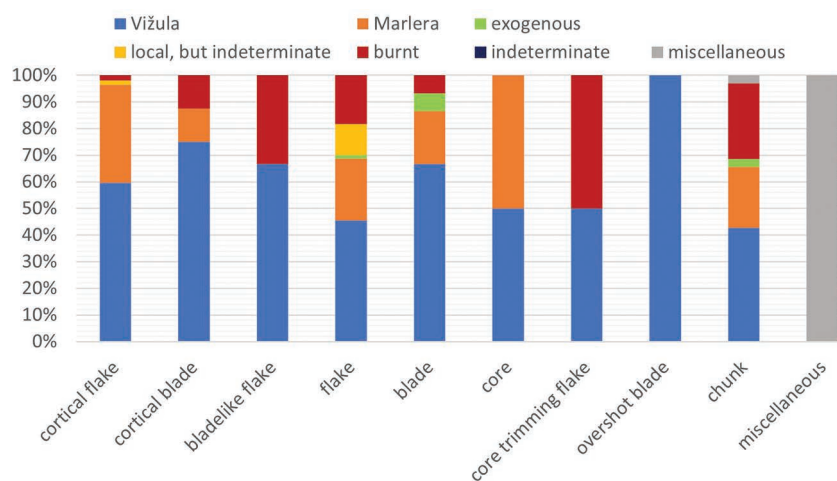
Sample 2 had a very characteristic colour also seen in some of the samples collected at the deposit. Similarity was also shown by micropetrographic analysis, as both samples contain round ‘ghosts’ of microfossils and a cryptocrystalline base (Fig. 19).

The third sample was a coarse white chert, and a comparison with the collected samples confirmed it too originated from Vižula. It is a diagenetic chert whose primary structure has been preserved, and we can observe probable calcispheres which are very common in sedimentary rocks of this formation (Fig. 20; Miko et al. 2013.36).

#### *Marlera chert*

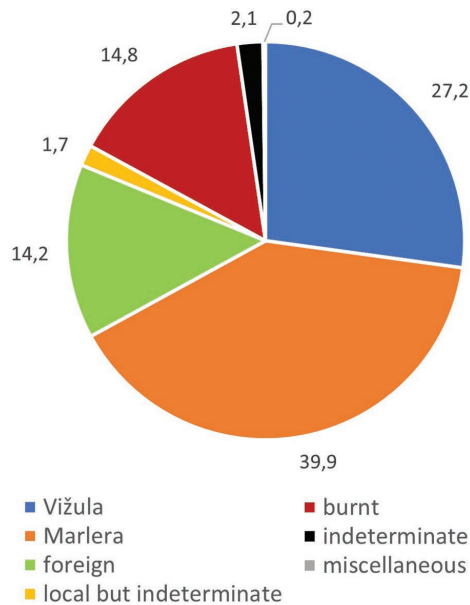
Marlera chert is mostly very light grey to medium dark grey (N8 to N4) with impurities of light blue, 5B 7/6 after Munsell (Šprem 2022.59). The five samples attributed to the Marlera deposit are laminated early diagenetic chert of greyish-blue colour. The first sample consists of cryptocrystalline to microcrystalline quartz and chalcedony, while the second sample is a laminated cryptocrystalline to macrocrystalline chert (Figs. 21 and 22).

The third sample is a dark blue chert with characteristic white inclusions. It is also characterized by the zonation of microcrystalline calcite (Fig. 23).



**Fig. 13. Chart showing the percentage of technological categories in the Early Neolithic horizon of Kargadur according to raw material.**

The fourth and fifth samples first stand out from the others by their macroscopic appearance. Nevertheless, we can link them to the Marlera deposit since we have also collected similar samples during our field surveys. It is a dark grey diagenetic chert with yellow carbonate inclusions of a fibrous texture. The cortex is also yellow in colour. The fourth sample can be described as a chert with a cryptocrystalline base, rich in ‘ghosts’ of microfossils, usually round and elongated, which we assume are sponge spi-

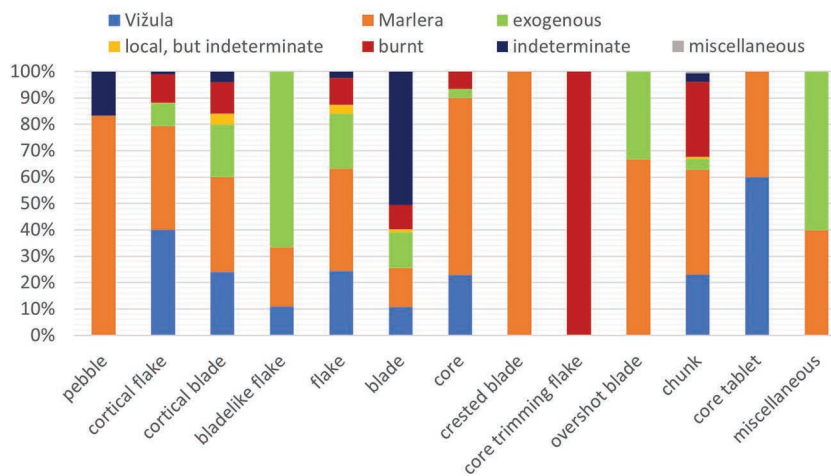


**Fig. 14. Raw material present in the analysed assemblage from the Middle Neolithic horizons of Kargadur.**

cules (Fig. 24.A and 24.B). The fifth sample is also a chert of cryptocrystalline base, with round 'ghosts' of microfossils from the primary structure and possibly sponge spicules (Fig. 24.C and 24.D).

#### Local chert of unknown origin

This raw material is a grey coarse-grained chert of poorer quality with white inclusions. Sample 1 is a cryptocrystalline chert rich in 'ghosts' of microfossils, namely ostracods, foraminifera, spicules of sponges (Fig. 25.A and 25.B). Sample 2 is very similar to the previous one, and is rich in 'ghosts' of microfossils. The base is cryptocrystalline, with parts that contain macrocry-



**Fig. 15. Chart showing the percentage of technological categories in the Middle Neolithic horizon of Kargadur according to raw material.**

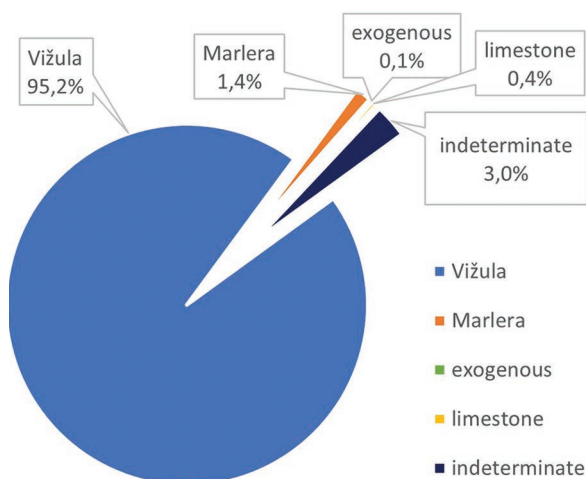
2 Bačić (1973) initially reported 40 pieces.

stalline quartz (Fig. 25.C and 25.D). These samples are very similar to the fourth and fifth Marlera samples, and therefore it is possible that this raw material is also originally from the Marlera deposit.

#### Comparison with other Neolithic sites in Istria and Dalmatia

The results of the lithic analysis of the knapped stone artefacts from the Kargadur and Vižula sites showed some similarities and differences between them. The main goal of the reduction strategy at both sites was flakes. Flakes were also the most frequent find at the Early Neolithic site of Vrčevan, located to the north of Kargadur and Vižula. However, due to the small number of lithic finds (12) in general (Komšo 2004.17), we must take this data with caution. Pupičina Cave in Vela Draga is represented by its *ad hoc* flake industry during the early phase of the Middle Neolithic, while prismatic blades became more common only during the later phase of the Middle Neolithic (Forenbaher 2006.250). Flakes and blades were equally represented at the Istrian site Vela Gromača near Kavran, where an Early Neolithic layer with 36 lithic artefacts<sup>2</sup>, along with pottery and bone finds, was excavated beneath a Bronze Age burial (Bačić 1973; Kačar 2019a.508). This is a clear difference to the other Neolithic sites in Dalmatia, which were oriented to the production of blades from the earliest Neolithic (see Kačar 2019b.360 and the bibliography listed there).

The presence of exogenous chert is also different between the two analysed sites. While at Kargadur exogenous chert is represented by between 1.4% of the artefacts in the Early Neolithic and 14.2% during Middle Neolithic (this does not take into account the obsidian fragments mentioned earlier), exogenous chert makes up 0.1% of all artefacts at Vižula (three pieces, with the total number of artefacts being 2834). It is interesting to note that the amount of raw material from Vižula decreases in the Middle Neolithic horizons at Kargadur, compared to the presence of this raw material during the Early Neoli-



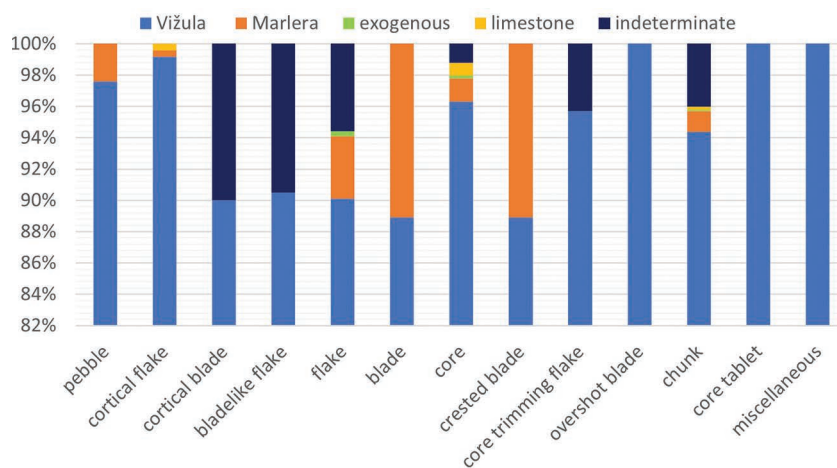
**Fig. 16. Raw material present in the analysed assemblage from Vižula.**

thic. At the same time, the percentage of exogenous raw materials, as well as raw materials from Marlera, increases. A similar strategy for obtaining raw materials was also used by the inhabitants of Pupičina Cave in the Vela Draga canyon. During the older phase of the Middle Neolithic, the representation of local raw materials is dominant, and the situation changes during the younger phase of the Middle Neolithic, when 'light' (exogenous) cherts are represented up to 58%. Obsidian also appears in the Late Neolithic phase of Pupičina Cave (Forenbaher 2006.238). The opposite is true for Vela Cave, which is located across from Pupičina. In the Late Neolithic phase, the representation of 'light' cherts decreases compared to the Middle Neolithic phase, and the representation of local 'dark' and 'reddish' cherts increases (Forenbaher, Nikitović 2007–2008.14). This can be explained by different activities being carried out at the two contemporaneous sites (O.c.22). The communities at Vrčevan and Vela

Gromača also relied heavily on local chert (Bačić 1973; Komšo 2004; Kačar 2019a).

There is only a small number of cores from exogenous raw material recorded at the analysed sites: two cores in the Middle Neolithic horizon of Kargadur, one at Vižula. Cortical flakes and blades of exogenous chert are only recorded in the Middle Neolithic phase of Kargadur. Almost a quarter of all the blades from Kargadur are from exogenous chert and a slightly higher percentage of blades were made from Vižula and Marlera chert. Judging by this data, with the absence of crested blades and only one overshoot blade of exogenous raw material recorded in the Middle Neolithic phase of Kargadur, exogenous blades were probably made off-site and brought to Kargadur in this form, but we cannot exclude the possibility that they produced blades on site as well. This was also probably the case with exogenous chert from the Middle Neolithic layers of Pupičina Cave (Forenbaher 2006.248), but not on Neolithic sites in Dalmatia where Gargano chert was brought in the form of prepared or semi-prepared cores (Kačar 2019b.361). There are a total of nine blades recorded in the Vižula sample; eight of them were made from Vižula chert, and one from Marlera chert; no exogenous raw material.

Another indicator of trade in the northern Adriatic, more precisely between Kvarner and distant places during the Middle Neolithic period is represented by two finds of chert from the Vorganjska Cave on Krk (Sirovica et al. 2021). Recent research has found two flint artefacts; one flake from the layer with Danilo pottery and one blade from a secondary context, both of which visually correspond to flint deposits recorded in northern Italy and on the Gargano peninsula (O.c. 14–15).

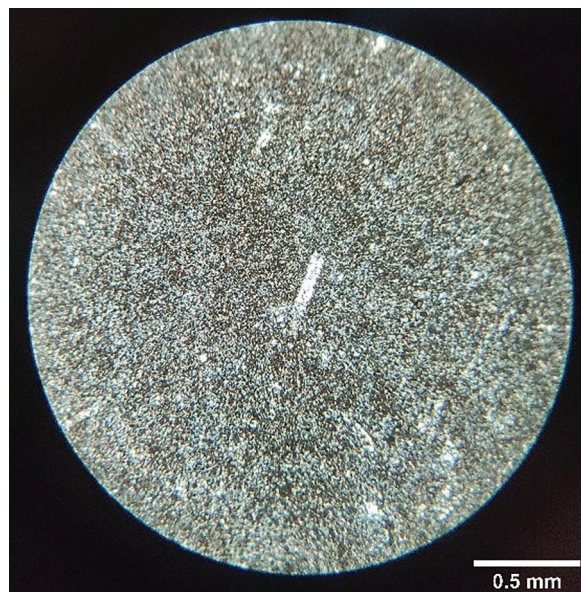


**Fig. 17. Chart showing the percentage of technological categories according to raw material.**

All the mentioned Neolithic sites in Istria – Kargadur, Vižula, Vrčevan, Pupičina Cave, Vela Cave – had locally available chert within an aerial distance of four kilometres or less, except Vela Gromača. For Pupičina and Vela Cave, these are the deposits established by P. Pellegatti through field surveys: Gabra gora, Gradec and Kupice on the southern slopes of Čičarija. There are also primary chert deposits on the southern slopes of Učka mountain (Pelle-

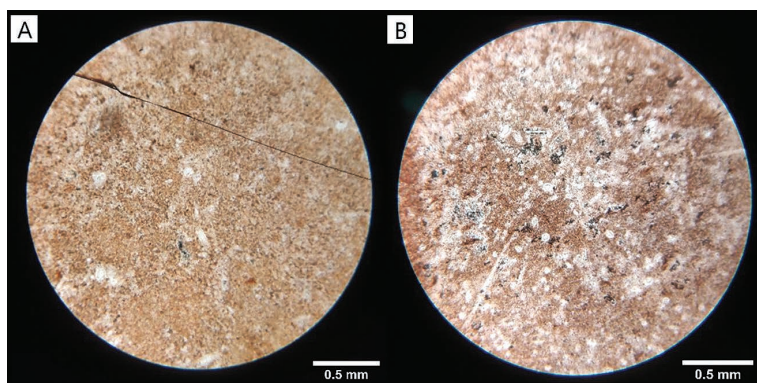
*gatti 2009; Šprem 2022.36–42; 2023.11–18*). For Kargadur, Vižula and Vrčevan, the closest locally available deposits are Marlera, Vižula, Runke Cape, Polje Bay and Kala Bay (*Šprem 2022.46–57; 2023.21–30*). Nevertheless, all 36 pieces from Vela Gromača are of local chert grey in colour (*Kačar 2019a.508*). Primary decortication of the local raw material was carried out both at Kargadur and Vižula, since cortical flakes are among the most represented technological categories. At Vrčevan, on the other hand, the decortication was done away from the site (*Komšo 2004.18*).<sup>3</sup>

The difference between Kargadur and Vižula can also be found in the number of retouched artefacts. While at Kargadur the percentage of tools in the Early Neolithic horizon is 8.3% and in the Middle Neolithic 10.2%, at Vižula the percentage of tools is very low – only 3.3%. Very little investment into retouching the blanks at Vižula has also been observed by other authors (*Andreasen 2009.57*). The most common tool at both sites is a retouched piece. These are so-called *ad hoc* tools that were made according to the current need. On

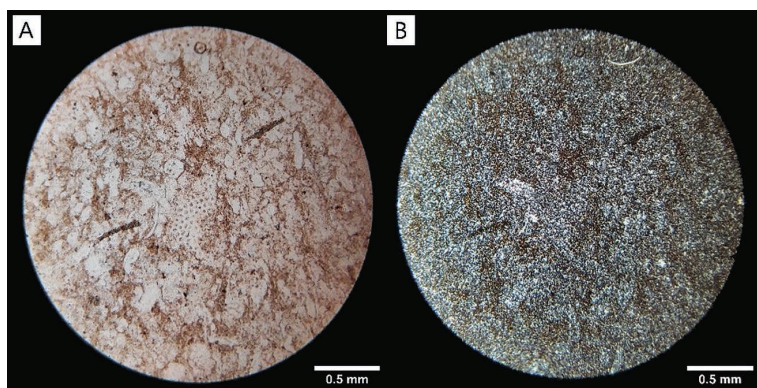


**Fig. 18. Photography of Vižula sample 1. XPL, magnification 40x.**

the other hand, Pupićina Cave yielded almost 30% of tools in the assemblage, with scrapers being the most frequent one. Almost half of all the tools were made on blades or bladelets and a third were made on flakes (*Forenbaher 2006.237*), while on Kargadur and Vižula tools were mostly made on flakes and cortical flakes.



**Fig. 19. Photography of Vižula sample 2 (A) and sample collected at Vižula deposit (B). PPL, magnification 40x.**

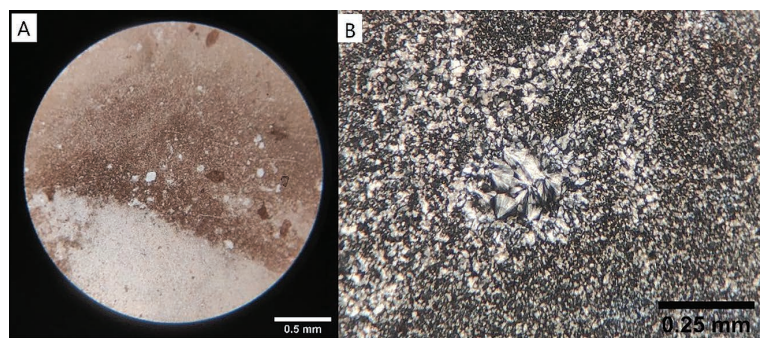


**Fig. 20. Photography of Vižula sample 3. Primary structure can be seen. PPL, magnification 40x.**

It is assumed that the Early Neolithic farmers who migrated to Dalmatia from Apulia and spread agriculture did not have knowledge of local chert deposits, so they brought chert with them from well-known deposits. Therefore, the transition to agriculture also marked an almost complete transition to exogenous high-quality chert from the Gargano deposit (*Forenbaher 2021.128–129*). Stašo Forenbaher cites the example of Nakovana cave, where chert from Gargano was used to a greater extent than local chert, starting from the earliest Neolithic until the end of the Bronze Age, when it disappeared from use (*Forenbaher, Perhoč 2015.65–66*).

One of the earliest Neolithic sites in Dalmatia – Rašinovac – which dates back to the first century of the 6<sup>th</sup> millennium

<sup>3</sup> This is just a hypothesis since the number of lithic artefacts is too small to make any conclusions.



**Fig. 21. Photography of Marlera sample 1. A Zoning in the sample, PPL, 40x. B Chalcedony in the sample, XPL, magnification 100x.**

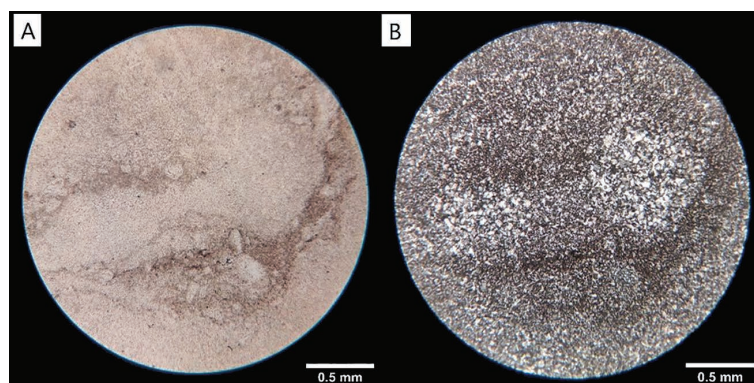
BC, yielded 70 lithic artefacts, along with impresso pottery (Podrug et al. 2018). Most of the raw material could not be determined petrographically, but the cherts that could be identified as local diagenetic cherts from Lower Eocene or Middle Eocene, as well as cherts from the Gargano deposit on the western Adriatic coast (Podrug et al. 2018. 70–73). The analysis of raw materials from other Neolithic sites in Dalmatia, including Danilo, Smilčić, Pokrovnik, Crno Vrilo and Velištak, is currently underway. Nevertheless, preliminary data already indicates that chert from Gargano was a frequently used and favourite raw material of the Neolithic period in Dalmatia (Forenbaher 2021. 128–129).

When it comes to the reduction process, a characteristic of the Neolithic on the Eastern Adriatic coast is the focus of the reduction strategy on the production of blades (Kačar 2019b.360). Such blades in Dalmatia were probably made using a pressure technique that is different and more complex than that used during the late Mesolithic and in Castelnovien industry (Kačar 2021.806). Although the pressure technique had been known since the Upper Palaeolithic (Inizan et al. 1999.32), it became widespread only in the late Mesolithic (Kačar 2019b.358 and the bibliography cited there). However, the pressure technique using a lever, recorded at sites in southern Italy and Greece, is certainly a Neolithic innovation that came from the East (Kačar 2021.806–807). There is no sign of any pressure technique in the reduction strategy of the analysed assemblages from Kargadur or Vižula.

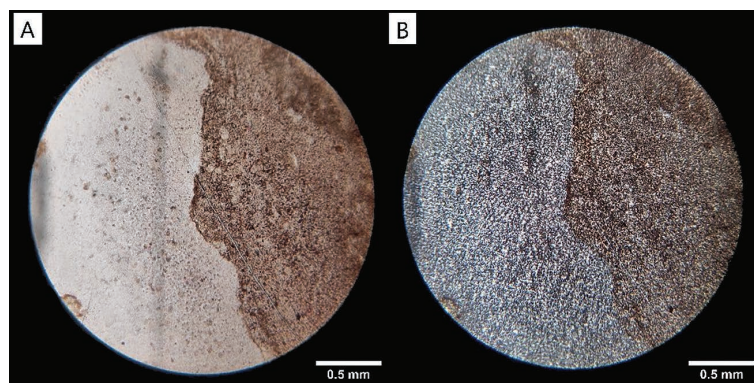
## Conclusion

The lithic analysis of knapped stone artefacts from the sites of Kargadur and Vižula made it possible to draw some hypotheses about the circulation of raw materials during the Neolithic in the south of the Istrian peninsula. Kargadur is a site from the Early and Middle Neolithic not far from Ližnjan, Istria, Croatia. The analysed set of stone artefacts from trench 3 numbers 1482 pieces. The main goal of the reduction strategy by

the communities during both the Early and Middle Neolithic was flakes. Judging by the presence of a large number of cortical flakes, the raw material was brought to the site where the core preparation was done. It seems that some of the blades were also made at the site, judging by the presence of crested and overshot blades. Exogenous raw material was also brought to site during the Middle Neolithic, the cores prepared there, and flakes and blades knapped.



**Fig. 22. Photography of Marlera sample 2. Cryptocrystalline and microcrystalline quartz in the sample. A PPL, magnification 40x, B XPL, magnification 40x.**



**Fig. 23. Photography of Marlera sample 3. A PPL, B XPL. Magnification 40x.**

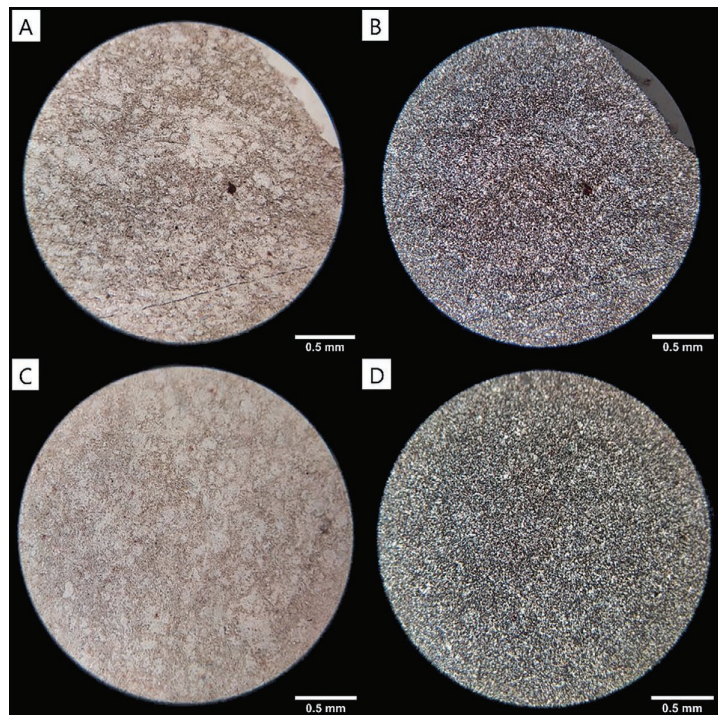
Flakes were also the main goal of the reduction strategy during the Early Neolithic at Vižula. Debris is represented by almost a third of all the analysed pieces, which is not surprising considering the low quality of the local raw material used extensively at the site. Blades are represented by nine pieces, all made from local chert.

As was established earlier, communities at Kargadur and Vižula, as well as at Vrčevan and Vela Gromača (Bačić 1973; Komšo 2004; Kačar 2019a), relied heavily on local chert, with exogenous chert only gaining in popularity during the Middle Neolithic phase of Kargadur. Reliance on local chert seems to be a characteristic of the Early Neolithic in Istria (Bačić 1973; Codacci 2002; Komšo 2004; Šprem 2022). Nevertheless, exogenous chert was present at the Early Neolithic horizons both at Kargadur and Vižula, albeit in small numbers, which can be interpreted as these communities either being familiar with deposits of exogenous high-quality chert or a part of the already established distribution networks, and not as “evidence of limited familiarity with the surrounding environment” (Andreassen 2009:57). Istrian peninsula was located outside the

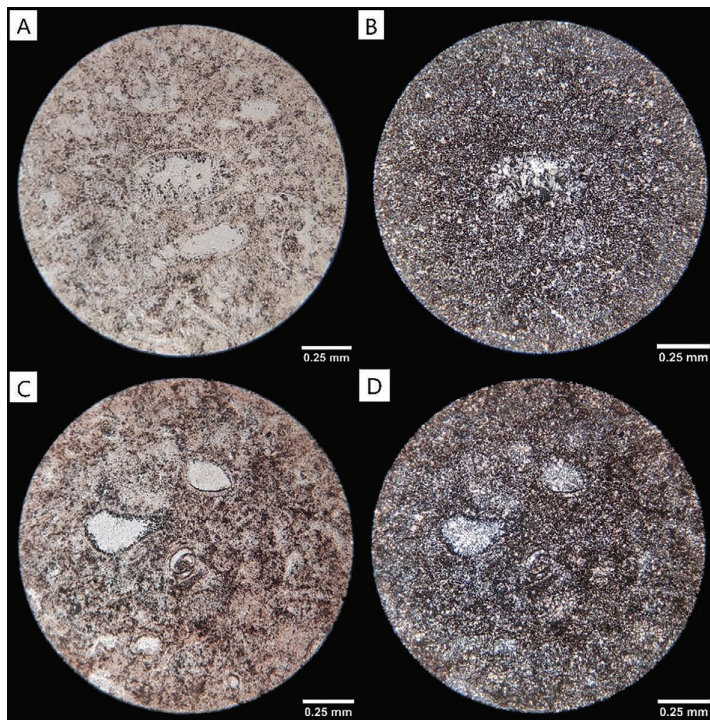
Gargano distribution network, and more oriented towards Northern Italy, which our data seems to confirm. This would suggest that the Neolithisation of the Adriatic was indeed not a single, but a multilinear process (Kačar 2021:809–810).

The site of Kargadur shows us that Middle Neolithic brought a clearer shift towards exogenous chert. This is also testified in Pupčina Cave where ‘light’, exogenous chert is prevalent (Forenbaher 2006). The Istrian peninsula gravitated towards Northern Italy with its deposits of high-quality chert. It was also outside of the Gargano distribution network, a raw material present and very popular from the earliest Neolithic on Dalmatian sites. The presence of obsidian in the Middle Neolithic layers of Kargadur coming from the Aeolian islands also give evidence to a branched network of raw material exchange.

This analysis also shows the complexities of using micropetrographic analysis for provenance studies of Istrian chert. All local chert in Istria is diagenetic, meaning it is silicified limestone, therefore the primary structure can be seen in the samples more or less clearly. However, none of them stand out at

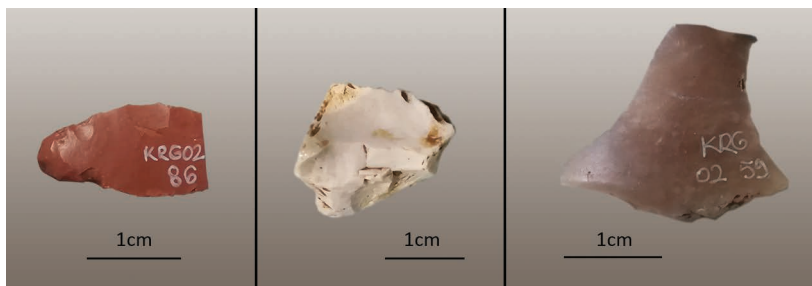


**Fig. 24. Photography of Marlera samples 4 (A and B) and 5 (C and D). Relics of microfossils can be seen in the samples. A, C PPL, C, D XPL. Magnification 40x.**



**Fig. 25. Photomicrographs of samples of local chert of unknown origin. Relics of microfossils are frequently seen. A, B sample 1, C, D sample 2. A, C PPL, B, D XPL. Magnification 100x.**

a microscopic level; the differences we see macroscopically (the colour, the zonations, the laminations) are usually also there to be seen through a microscope. We suggest we might get better results with geochemical analyses, which already showed some promise in our case (Šprem 2022; 2023).



**Fig. 26. Lithic finds from Kargadur made from exogenous raw material assumed to be from Monti Lessini, Italy.**

We would also suggest taking all these hypotheses with caution, since our analysis was conducted on a limited number of artefacts from the sites, and not whole assemblages, which was impossible to do at the time due to the pandemic. Nevertheless, this analysis is an important step for researching the Neolithic period in the Istrian peninsula,

since it deals with often overlooked set of finds which can enrich our knowledge of the period in question. After more analyses are done, we can have a better understanding of the lithic production in the Istrian Neolithic.

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