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GRINDING INSTALLATIONS IN PRE- AND PROTOHISTORIC EURASIA. A CASE STUDY FROM GEORGIA – TYPOLOGICAL, TRACEOLOGICAL AND EXPERIMENTAL STUDY OF A GRINDING INSTALLATION FROM GRAKLIANI HILL ARCHAEOLOGICAL SITE

ABSTRACT

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The paper investigates grinding installations found across diverse archaeological sites in Eurasia, spanning from the Neolithic (10000-8800 BCE) to the Early Roman period (2nd century BC) in regions such as Georgia, Bulgaria, Turkey, Israel, and Moldova. The study employs typological, traceological, experimental and comparative analyses. A significant focus is on the interdisciplinary examination of an installation at Grakliani Gora, representing the first comprehensive study within Georgia's territory.

This study aims to fill knowledge gaps regarding the origin, types, and functions of grinding installations found at archaeological sites like Gesher, Ulucak Höyük, Varvarovka VIII, Branzeni III, Kodzadermen, Liga, Ilipinar, Shiqmim, Tel Rehov, Grakliani Gora, Tsikhiagora, and Dedoplis Gora. Notable shared characteristics include indoor placement, using clay in platform construction, surrounding walls to contain scattered flour and the incorporation of side recesses for the material being ground or the produced flour. These installations were constructed to enhance the efficacy of working devices, increase flour yield, and minimize physical strain during daily activities.

Keywords: Neolithic, Bronze Age, Classical Period, Georgia, Grinding Installation
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INTRODUCTION

The use of grinding stones as essential agricultural tools spans a wide historical timeline, dating from the Upper Paleolithic period to the Classical period (Ebeling and Rowan 2004, 109; Dzidziguri 2000, 135-184). These artefacts are commonly discovered both within and outside buildings at archaeological sites. This study specifically delves into the examination of grinding stones positioned on a clay structure found in Room B at the Graklian Gora site (settlement and cemetery), located in Central Transcaucasia, Georgia, within the territory of the Samtavisi and Igoeti villages in the Kaspi district. The chronological position of the platform was determined by the ceramic artefacts found within the layer of the building's collapse (Licheli 2014, 12, 13; 2020, 48), attributing the room to the Achaemenid period (5-4 century BC) (Fig. 1). The structure comprises a quadrangular platform where two querns were affixed. Notably, this investigation marks the pioneering analysis of the grinding platforms at Grakliani Gora. A comprehensive approach integrating typological, traceological, and experimental methodologies was adopted to comprehend these structures. According to the typological system revealed the presence of an oval-shaped basalt quern with a flat working surface and a saddle-shaped sandstone quern with a concave working surface (Tetruashvili 2018, 92, 93). Traceological research confirmed that these grinding stones were primarily used for grain processing. Moreover, experimental efforts were pivotal in reconstructing the entire cycle, from the construction of the grinding installation to the actual grain grinding process.

A grinding installation is a specially prepared platform designed for grinding stones (querns). The term 'grinding installation' was first introduced in the article by J. Ebeling and Y.M. Rowan in 2004, in which they discussed devices found in archaeological sites in Israel, including Shiqmim and Tel Rehov (Ebeling and Rowan 2004, 11-114). Further exploration into scientific literature revealed evidence of grinding devices at various archaeological sites such as Gesher in the Pre-Pottery Neolithic A period in Israel, dated 9600-9200 BC (Garfinkel and Dag 2006, 51-53); the Late Neolithic site Ulucak Höyük in Turkey, dated 5840-5710 BC (Cilingiroglu *et al.* 2004, 1-51). They also occur at Neolithic-Chalcolithic sites, such as Varvarovka VIII and Brandzeni III in Moldova, dated 5500 to 2750 BC (Cotiuga *et al.* 2016, 703-706); Chalcolithic sites Liga and Kodzadermen in Bulgaria dated to the 5th millenium BC (Merkyte 2005, 54, 55); Ilipinar in Turkey, dated to 5700 BC (Sagona and Zimansky 2009, 130-136); Shiqmim in Israel, dating to 4500 BC (Ebeling and Rowan 2004, 111). They are found on the Late Bronze Age archaeological site of Tel Rehov, Israel, dated to the 9th century BC (Ebeling and Rowan 2004, 114); the Achaemenid period building of site Grakliani Gora, Georgia, 5-4th century BC (Licheli 2014). Other examples are found in Post-Achaemenid (3rd century BC- the middle of the 2nd Century BC) and Hellenistic period (3rd-2nd century BC) buildings of the site at Tsikhiagora, Georgia (Tskit'ishvili 2003, 19; Makharadze *et al.* 2023, 13, 17), as well as the Early Roman period (2nd century BC) building of Dedoplis Gora, Georgia (Gagoshidze 2019, 187-188).

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Grakliani Gora Excavated Area plen

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Fig. 1. 1. Location of Grakliani Gora archaeological site; 2. Plan of the Grakliani Gora excavated area, with the red-marked area indicating Room B where the grinding installation was discovered. Photo by D. Dolaberidze and I. Zukakishvili

The tradition of utilizing grinding installations in the territories of Eurasia is well-documented from the Neolithic period to the early Roman period. By studying the Grakliani Gora installation and comparing it with similar findings in the scientific literature, two distinct types of installations may be identified. The first type consists of a floor-based installation featuring a boundary wall, examples of which are found at: Gesher (Garfinkel and Dag 2006, 51-53; Varvarovka VIII and Brandzeni III (Cotiuga *et al.* 2016, 703-706); Ulucak Höyük (Cilingiroglu *et al.* 2004, 1-51); Liga and Kodzadermen (Merkyte 2005, 54, 55).

The second type consists of a platform-based installation characterized by side recesses and a flour container situated in front of the grinding stone. Examples have been found at: Ilipinar (Sagona and Zimansky 2009, 130-136); Shiqmim (Ebeling and Rowan 2004, 111); Tel Rehov (Ebeling and Rowan 2004, 114); Grakliani Gora (Licheli 2014); Tsikhiagora (Tskit'ishvili 2003, 19; Makharadze *et al.* 2023, 13, 17) and Dedoplis Gora (Gagoshidze 2019, 187-188).

MATERIALS AND METHODS

Investigative Area and Description of the Grakliani Gora Installation

This study centres on Room B of the Grakliani Gora site, where a platform with grinding stones was found in situ. Room B measures 5 metres in length from east to west and 3.4 metres in width. Positioned on the northwest side of the oven is a clay-plastered platform measuring 1.35 centimetres in length, 50 centimetres in width, 30 centimetres in height, with two querns affixed to it (Fig. 2).

Grinding stone No. 1, made of basalt, with a width of 28 centimetres, is fixed in a specially prepared clay quadrangular structure. It features two oval-shaped recesses plastered with clay: one on its left side measuring 34 centimetres in length, 18 centimetres in width, and 8 centimetres in depth; the other on its right side with dimensions of 33 centimetres in length, 17 centimetres in width, and 8 centimetres in depth. Grinding stone No. 2, made of sandstone and saddle-shaped with a width of 26 centimetres, it also has two side recesses plastered with clay. These recesses, separated by an 11-centimetre ramp from the recess on the right side of grinding stone No.1, have dimensions of 33 centimetres, 18 centimetres in width, and 8 centimetres in depth, and the one located on the right of hand grinder No. 2 has dimensions 34 centimetres in length, 17 centimetres in width, and 10 centimetres in depth (Tetruashvili 2018, 61, 62).

Typological-comparative analysis of grinding installations

A comprehensive examination of 14 grinding installations involved a systematic categorization based on distinct platform and quern characteristics. These installations commonly comprised attached querns, surrounding walls, side recesses, and flour containers (Fig. 3).

A characterisation of the platforms revealed the prevalence of circular, oval, and quadrangular shapes with some sites demonstrating the use of surrounding walls. Side recesses, intended for the placement of materials before or after the grinding process, as well as flour containers, were observed in installations such as at Shiqmim, Grakliani Gora, Tsikhiagora, and Dedoplis Gora, facilitating the containment and efficiency of the grinding process (Table 1).

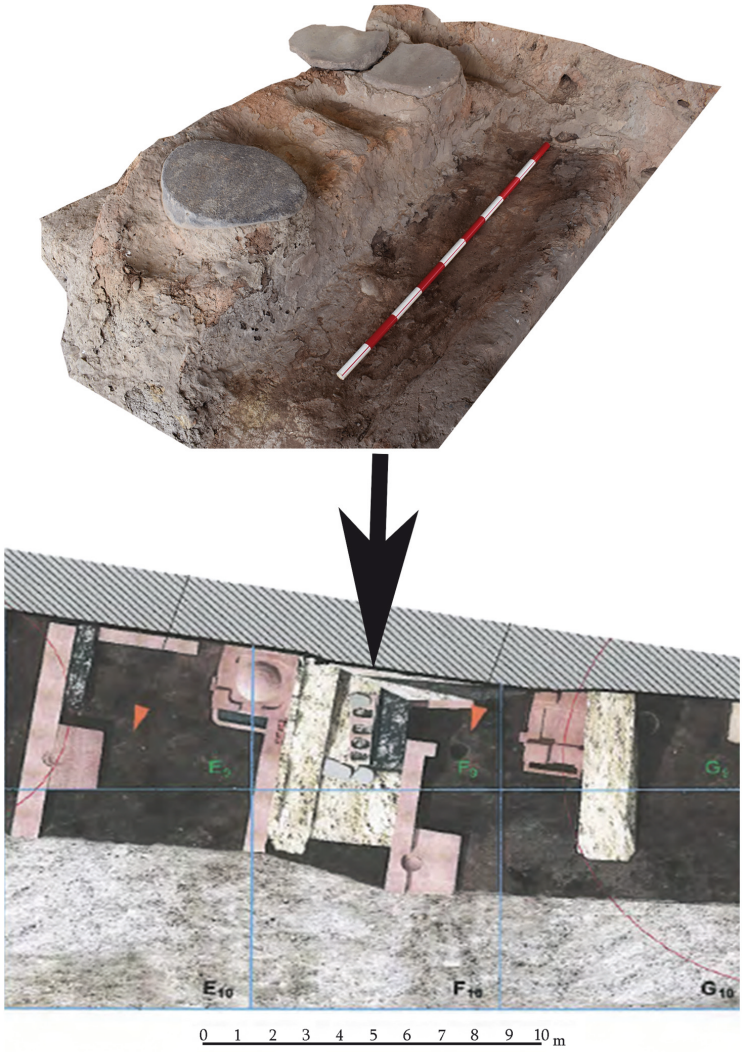

Fig. 2. Grakliani Gora, third terrace, Room B and location of installation.
Photos were taken during the archaeological fieldwork in 2014.
Photo by D. Dolaberidze and the plan was made by the architect M. Kasradze

Determining quern characteristics was facilitated by a reference collection, highlighting the shapes and working surfaces, predominantly featured quadrangular and oval-shaped querns, with flat and concave working surfaces. Additionally, some instances indicated the use of basalt as a raw material for the quern. The number of grinding stones attached to the platform is 1 or 2, with 32 in one exceptional case (Table 2).

Table 1. Grinding installation – platform characteristics

Chronology	Archaeological Site	Installation Placement Inside the Building	Platform shape	Platform structure			Recess	Surrounding wall	Flour container
				clay	Earth, stone, clay	N/A			
Neolithic, PPNA, 9600-9200 BC	Gesher, Israel	●	Circle	●					
Late Neolithic, 5840-5710 BC	Ulucak Höyük, Turkey	●	Circle	●				●	
Neolithic-Chalcolithic, 5500 to 2750 BC	Varvarovka VIII, Moldova	●	Circle			●		●	
Neolithic-Chalcolithic, 5500 to 2750 BC	Branzeni III, Moldova	●	Circle			●		●	
Chalcolithic, 5th millenium BC	Kodzadernen, Bulgaria	●	Oval	●				●	
Chalcolithic, 5th millenium BC	Liga, Bulgaria	●	Oval	●				●	
Chalcolithic, 5700 BC	Ilipinari, Turkey	●	Oval	●					
Chalcolithic, 4500 BC	Shiqmim, Israel	●	Circle		●		●		●
Late Bronze Age, 9th century BC	Tel Rehov, Israel	●	Circle	●				●	●
Achaemenid period, 5-4th century BC	Grakliani Hill, Georgia	●	Quadrangular	●	●		●		●
Post-Achaemenid period, 3rd century BC- the middle of the 2nd Century BC	Tsikhiagora, Georgia	●	Oval	●			●		●
Hellenistic period, 3rd -2nd century BC	Tsikhiagora, Georgia	●	Oval	●					●
Hellenistic period, 3rd -2nd century BC	Tsikhiagora, Georgia	●	Quadrangular	●					●
Early Roman Period, 2nd century BC	Dedoplis Gora, Georgia	●	Quadrangular	●			●		●

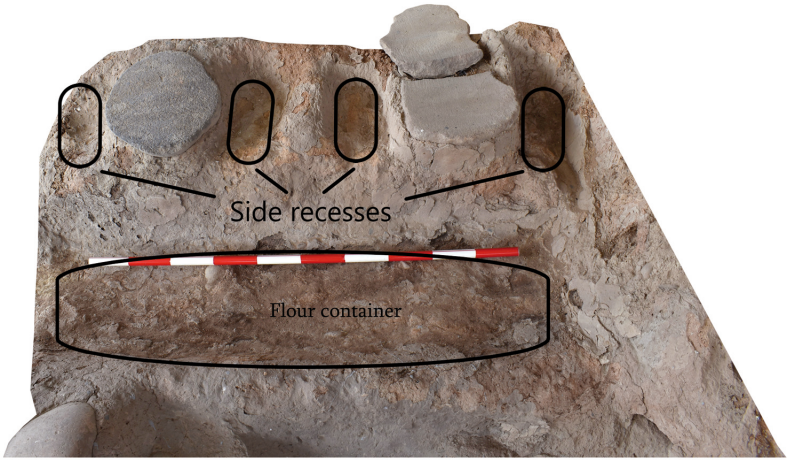

Fig. 3. Grakliani Gora characteristics of the grinding installation. Photo by D. Dolaberidze

Table 2. Grinding installation – quern characteristics

Chronology	Archaeological Site	Quern type	Quern working surface	Quern position	Quern raw material	Amount
Neolithic	Gesher, Israel	Quadrangular	Concave	Horizontal	N/A	1
Late Neolithic	Ulucak Höyük, Turkey	Oval	Flat	Horizontal	N/A	1
Neolithic-Chalcolithic	Varvarovka VIII, Moldova	N/A	N/A	Horizontal	N/A	1
Neolithic-Chalcolithic	Branzeni III, Moldova	N/A	N/A	Horizontal	N/A	1
Chalcolithic	Kodzadernen, Bulgaria	Oval	Flat	Horizontal	N/A	1
Chalcolithic	Liga, Bulgaria	Oval	Flat	Horizontal	N/A	1
Chalcolithic	Ilipinari, Turkey	Oval	Flat	Inclined	N/A	1
Chalcolithic, 4500 BC	Shiqmim, Israel	Oval	Concave	Inclined	Basalt	1
Late Bronze Age, 9 century BC	Tel Rehov, Israel	Quadrangular	Concave	Inclined	N/A	1
Achaemenid	Grakliani Hill, Georgia	Oval	Flat, concave	Horizontal	Basalt, and Sandstone	2
Post-Achaemenid	Tsikhiagora, Georgia	Oval, and quadrangular	Flat, concave	Inclined	Basalt	32
Hellenistic	Tsikhiagora N12, Georgia	Quadrangular	Flat	Inclined	N/A	2
Hellenistic	Tsikhiagora N17, Georgia	Quadrangular	Flat	Inclined	N/A	2
Early Roman Period	Dedoplis Gora, Georgia	Quadrangular	Flat	Inclined	Basalt	1

Traceological analysis

In the study of the grinding installation from Grakliani Gora, traceological analysis was applied, involving the examination of the querns' working surface using an Omax binocular microscope and Dino-Lite digital microscope with a magnification ranging 50×-100×. This analysis revealed that the basalt quern's working surface was smooth and polished, with traces covering the entire surface (Fig. 4). Intensive use was evidenced by concentrated traces in the middle of the tool's working surface. Similarly, the sandstone quern's working surface exhibited parallel linear traces, which were concentrated in the middle (Fig. 5).

Experimental Study of the Grinding Installation

The experimental study of the Grakliani Gora grinding installation involved the collection of necessary building material for construction: 20 bags of clay (approximately 50 kilograms each) from Bozham village (4.4 km away from Grakliani Gora), cobblestones collected from the banks of the Lekhura river near Samtavisi village, and stubble purchased from a local farmer. The construction of the installation lasted 18 days, hindered by adverse weather conditions such as rain and low temperatures, necessitating the use of fire to dry the clay. A man and a woman were involved in the construction process, using 400-470 kilograms of clay for installation, a bundle of stems and 70-80 cobblestones (Tetruashvili 2023, 56).

The experimental installation (Fig. 6) measured 60 centimetres in height and 95 centimetres in width, matching the dimensions of the Grakliani Gora grinding installation except for its length, which extended to 157.5 centimetres due to adjustments necessitated by the experimental querns' width and the deformed left-side wall of the Grakliani Gora installation (Tetruashvili 2023, 56).

The grinding process, conducted by a woman took approximately 2 hours to grind 2 kg wheat and barley grain. The process involved repeatedly grinding the product three times to obtain fine-grained flour (Tetruashvili 2023, 57).

Data Analysis

In the examination of grinding installations, our objective was to discern both common and distinctive features by conducting detailed assessments involving reference collections, and typological,traceological, experimental, and comparativeanalysis.

The typological and petrographic study of the Grakliani Gora grinding installation revealed two distinct quern attachments made from different raw materials. The petrographic study of the artifacts was conducted by PhD M. Makadze from Iv. Javakhishvili Tbilisi State University, using binoculars, various types of handheld magnification (10×,

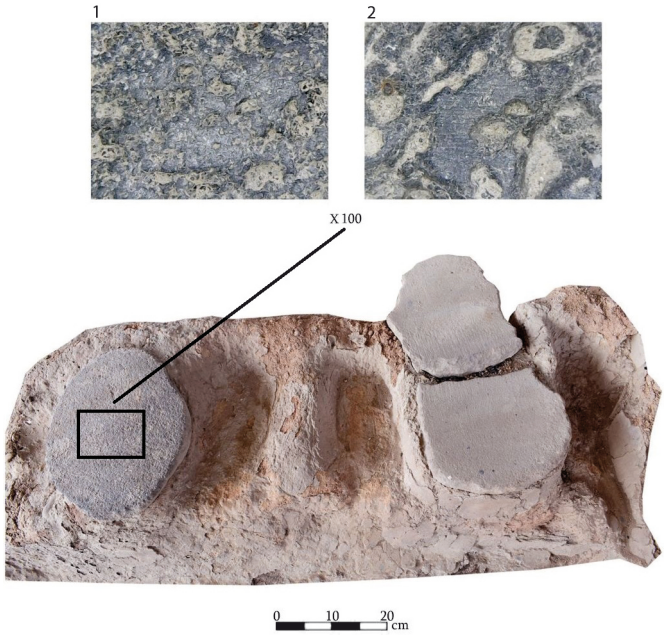

Fig. 4. Use-wear traces observed on basalt quern from Grakliani Gora grinding installation:
1. Polish and smooth traces; 2. Smooth and scratch traces. Photo by A. Tetruashvili and D. Dolaberidze

Fig. 5. Experimental grinding installation. Photo by D. Dolaberidze

Fig. 6. Linnear trace on sandstone quern from Grakliani Gora grinding installation.
Photo by A. Tetruashvili

20×), and 3% hydrochloric acid. This discovery prompted inquiries into the specific materials to be processed on the basalt and sandstone querns. In response to this question, we pursued traceological and subsequent experimental studies. Initially, it was believed that the presence of hand grinders with two distinct tool materials at the Grakliani Gora site indicated their use for processing different materials. However, experimental studies have confirmed that the use-wear marks on the querns of the Grakliani installation match those produced during grain processing experiments.

It is crucial to note that all examined installations were situated indoors, often placed close to ovens. Most of these installations had an oval shape and were predominantly constructed using clay as the primary material. Some grinding installations were enclosed by walls, primarily designed to minimize flour dispersion. Notably, the installations equipped with boundaries did not integrate side recesses. The positioning of the querns within these installations varied, either inclined or horizontal, based on the shape of the grinding installation.

Several key observations arise from the typological analysis:

1. Grinding installations at Ulucak Höyük, Varvarovka VIII, Branzeni III, Kodzadermen, Liga, and Tel Rehov although placed directly on the building's floor, all featured boundary walls (Cotiuga *et al.* 2016; Cilingiroglu *et al.* 2004; Merkyte 2005).

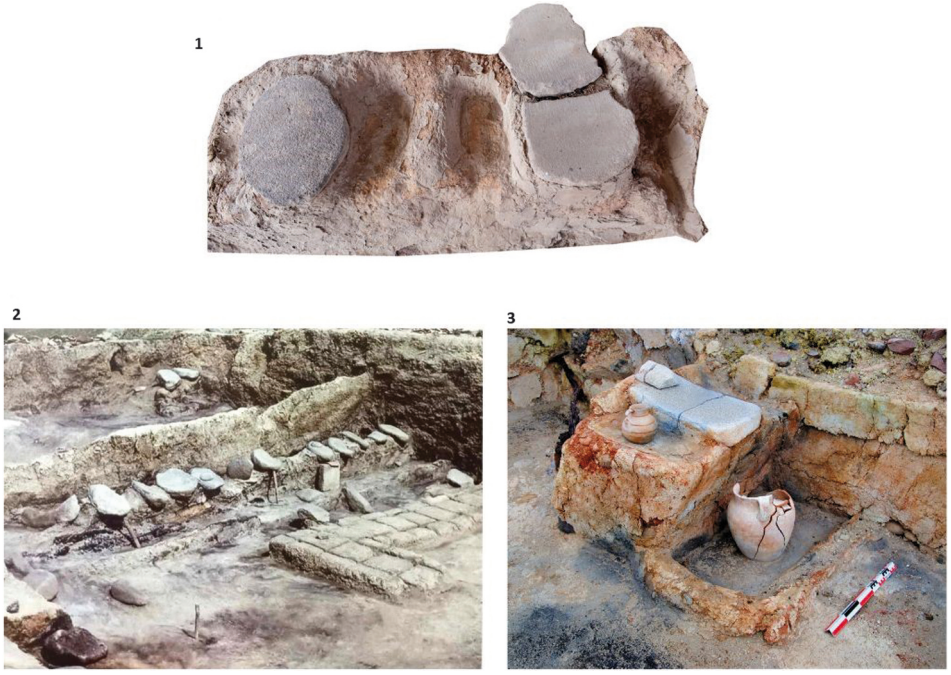

Fig. 7. Grinding installations: 1. Grakliani Gora; 2. Tsikhiagora (Makharadze *et al.*, 2023); 3. Dedoplis Gora, photo by D. Gagoshidze

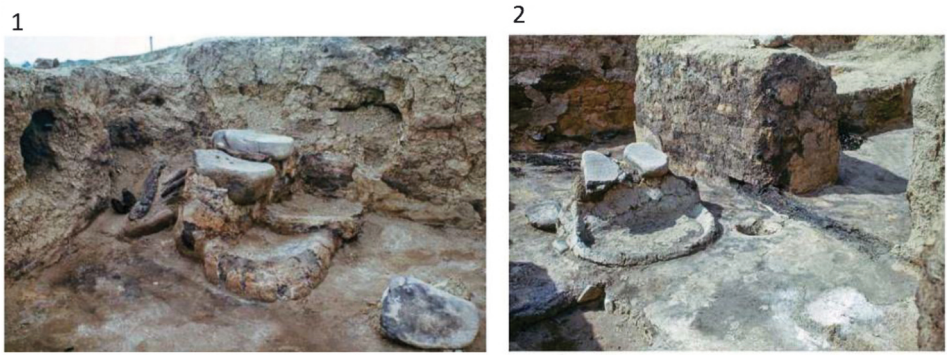

Fig. 8. Grinding installations: 1. Tsikhiagora, Room N17; 2. Tsikhiagora, Room N12 (Makharadze *et al.* 2023)

2. Installations with a boundary wall typically contained fixed horizontal quern stone(s) and did not include a flour container.

3. The installations at Shiqmim, Grakliani Gora, Tsikhiagora, and Dedoplis Goragrinding lacked a boundary wall, but featured side recesses meant for grinding or containing the milled flour. For instance, in the case of the Tsikhiagora grinding installation, the excavators suggest that the side recess adjacent to the quern was designed to contain the flour produced (Tskit'ishvili, 2003). The function of the recesses in the Grakliani Gora installation depended on the dynamics of the motion of the grinder. With a single-handed grinder using a circular motion, the ground flour accumulated in the recesses, whereas the flour produced by a two-hand grinder, operating with a back-and-forth motion, was discharged in front of the quern (Fig. 7).

4. Flour containers were exclusively present in installations (Grakliani Gora, Tsikhiagora and Dedoplis Gora) situated on platforms (Fig. 8).

CONCLUSION

The widespread presence of grinding installations across Eurasia from the Neolithic to the Early Roman period has revealed a spectrum of forms and functions integral to these essential tools. Notably, two primary types of installations have been discerned: 1. Floor-based structures with boundary walls (Gesher, Varvarovka VIII, Branzeni III, Ulucak Höyük, Kozadermen, and Liga), and 2. Specialized platform-based installations, the latter distinguished by the inclusion of flour containers or recesses (Shiqmim, Tel-Rehov, Ilipinar, Grakliani Gora, Tsikhiagora, andDedoplis Gora).

The manner of utilization of these grinding installations is closely connected to the type of installation and the positioning of the individual operating it. For instance, while the first type requires the user to kneel directly on thefloor, the second type accommodates

Fig. 9. 1. Back side of Dedoplis Gora grinding installation, photo by D. Gagoshidze; 2. Position of user during the grinding process, photo by D. Dolaberidze and drawings by T. Davadze; 3. Position of user during the grinding process, photo by D. Dolaberidze and drawings by T. Davadze

different stances, such as using the recesses on the back wall of the platform (as observed in Dedoplis Gora) or standing directly on the ground behind the installation. The hypotheses were validated during experimental work (Fig. 9).

Furthermore, the traceological study carried out on the querns at the Grakliani grinding installation have unveiled evidence of tool usage in cereal processing, a finding supported by subsequent experimental research. Our experiments, involving the grinding of cereals like wheat and barley, revealed identical characteristics on both the experimental and querns and those from the Grakliani installation. Additionally, the intentional use of two different types of stone tools was discovered: the cereal was initially ground on a porous basalt stone and then refined on sandstone to obtain a finer flour.

Upon assessing the quality of these grinding installations, it becomes apparent that installations with boundary walls or recesses offer a more productive and efficient grinding environment. These structures minimize the loss of the milled product and maintain fineness during the process, in contrast to mobile grinding stones.

In conclusion, the prevalence of grinding installations across various chronological stages and geographical regions is closely intertwined with the development of agriculture and the advancement of working devices. The evolution and variations in these installations indicate progression in human civilization. In the early stages of the development of these installations, they were placed on the floor, while in later periods, specialized platforms were created. The pivotal experimental and traceological studies conducted have significantly contributed to unravelling the intricacies of these ancient tools and understanding their significance in early human societies.

Acknowledgments

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