

# Emergence and Spread of a Neolithic South-Eastern European Pan-cultural Technological Tradition: Grog-tempered Pottery in Southern Romania During the Late Sixth and Fifth Millenniums BC

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*This study explores the emergence and dispersal of grog-tempered pottery in south-eastern Europe, particularly southern Romania. During the second half of the sixth millennium BC, a dynamic zone emerged between the Danube and the Carpathians, facilitating the spread of innovations through multiple communication routes. Among these innovations, grog-tempered pottery began to appear around 5300/5000 BC and became prevalent during the fifth millennium. Despite being frequent, its origins, dispersal, and intensity remain poorly understood. This article aims to trace and explain the emergence and distribution of grog-tempered pottery in southern Romania. By integrating data from existing literature with new results from macroscopic and archaeometric analyses of twelve pottery assemblages from Middle Neolithic, Early, and Middle Chalcolithic sites, the author seeks to provide insights into the significance of the first grog-tempered pottery in a south-eastern European context.*

**Keywords:** grog temper, pottery, technology, Neolithic, Chalcolithic, southern Romania

## INTRODUCTION

### Context, research gap, and aim of the study

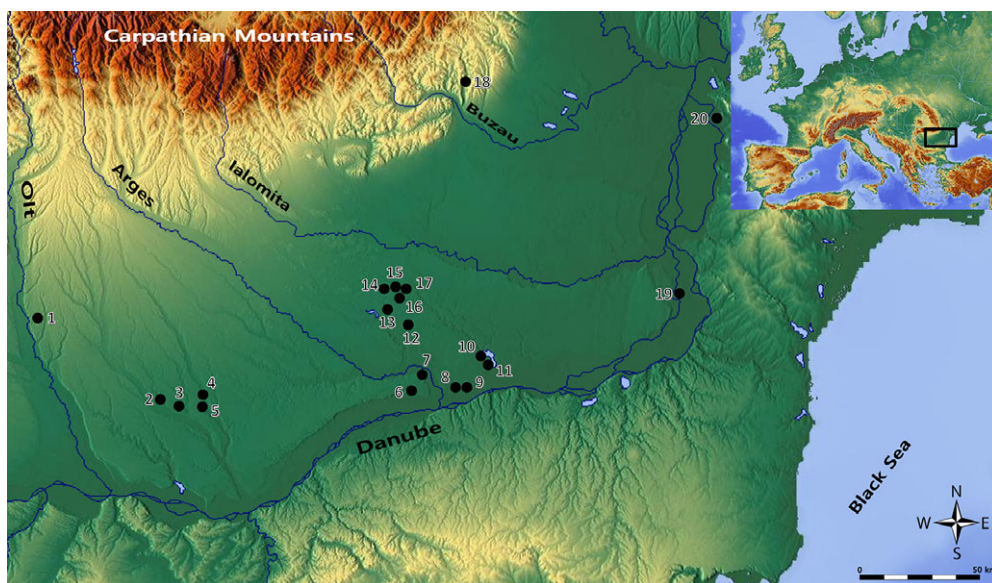
The introduction of ceramic technology to the Danube region occurred with the arrival of the first Neolithic communities (Jordan et al., 2016; Thissen, 2017), along a route originating in Anatolia, south-eastern Europe, approximately 8000 years ago (Mathieson et al., 2018). The change in type and frequency of pottery tempers represents one of the most striking technological differences

between the Early Neolithic and the Middle/Late Neolithic and Chalcolithic pottery traditions in the Middle and Lower Danube region. Pottery tempered with agricultural by-products, collectively termed chaff, is considered characteristic of early pottery assemblages, including those found in southern Romania. Recent studies have greatly advanced our understanding of this tradition, revealing its widespread distribution and persistence for nearly one millennium (Kreiter et al., 2013; Spataro, 2019; Papadakou et al., 2021; Dzhanfezova, 2021). Grog, or crushed pottery,

did not emerge as an intentionally used temper in the Early Neolithic of the Middle and Lower Danube Basin, nor in contemporary or adjacent cultures in the eastern Adriatic (Spataro, 2019). BC

During the second half of the sixth millennium BC, a buffer zone emerged between the Danube and the Carpathians in southern Romania (Figure 1), in which innovations spread through contact and exchange following multiple communication routes: south to north, west to east, and north to south (Reingruber, 2017). Based on scarce published information, it appears that grog-tempered pottery began to be used in the region around 5300/5000 BC (Ștefan, 2023), and became frequent during the fifth millennium BC (Comșa, 1974; Opriș et al., 2017; Koutouvaki et al., 2021; Stoicescu et al., 2023). Yet, little is known about the origin, dispersal, and intensity of this ceramic technology.

Over the past century, numerous researchers have investigated grog-tempered pottery from various analytical angles. While some scholars have primarily acknowledged the presence of grog within ceramic fabrics, others have delved deeper into the complexities of this tempering technique. These comprehensive case studies have expanded our horizons, addressing issues ranging from definitions and research methodology to technological properties, cultural traditions, economic networks, social implications, recycling practices, and ethnographic models (Whitbread, 1986; Kreiter, 2007; Holmqvist et al., 2018; Holmqvist, 2021). For the Middle and Lower Danube region, the use of grog by Middle Neolithic, Late Neolithic and Chalcolithic communities has been recognized as a common practice (Merkyte et al., 2005; Vuković, 2015, 2020; Spataro, 2017; Amicone et al., 2020). However, only sporadic data on this



**Figure 1.** Distribution map of Middle Neolithic and Chalcolithic sites in southern Romania with data on pottery inclusions analysed. 1) Milcovu din Deal; 2) Mavrodin-Pod; 3) Nanov-Vistireasa; 4) Măgura-Bran; 5) Teleor 008; 6) Căscioarele-Ostrovel; 7) Radovanu-La Muscalu; 8) Gumelnița-Tell; 9) Gumelnița-Terrace; 10) Sultana-Ghețarie; 11) Sultana-Malu Roșu; 12) Berceni-Site 12; 13) Bragadiru-La Moară; 14) Cbitila-Așezare; 15) Băneasa-Lac; 16) București-Șoseaua Nordului; 17) Crețuleasca; 18) Aldeni-Gurguiul Balaurului; 19) Bordușani-Popină; 20) Carcaliu (base map: <https://maps-for-free.com>).

tradition have been collected for in-depth analyses (see Hofmann, 2020 for the central and western Balkans). Grog has also been considered as a potential source of object fragmentation, albeit with caution, and viewed as exceptionally rare in some contexts (Chapman, 2000).

The aim of this article is to trace and explain the appearance and distribution of grog-tempered pottery in the late sixth and the fifth millennia BC in Romania's Lower Danube area, following specific objectives. These are: (i) investigating to what extent grog-tempered pottery was employed by Neolithic and Chalcolithic communities; (ii) detecting its temporal and geographical spread; (iii) identifying and explaining variability. The information gathered from published sources is combined with new results obtained from the macroscopic and archaeometric analyses of pottery assemblages from Middle Neolithic and Early and Middle Chalcolithic sites or levels from southern Romania.

### **Inclusions in the Neolithic and Chalcolithic pottery from Romania's Lower Danube region**

During the twentieth century, Neolithic and Chalcolithic pottery fabrics from southern Romania were typically classified into three main types: fine, semi-fine/medium, and coarse. These categories, established by scholars such as Dumitru Berciu (1961), Eugen Comşa (1974), and Valentina Voinea (2005), refer to the general characteristics of the inclusions in the paste, often without quantification of these inclusions. In many cases, the frequency of inclusions was assessed only approximately, leading to semi-quantitative data. These observations were then used to support theories of cultural evolution, suggesting transitions from one cultural phase to another.

Publications containing both qualitative and quantitative data on ceramic inclusions are relatively rare and have appeared

primarily in the last two decades. Notable examples include works by van As et al. (2006), Burens et al. (2010), Opriş et al. (2012, 2017), Thissen (2014), Opriş and Ştefan (2016), Lazăr et al. (2017, 2020), and Ştefan (2021, 2023). These studies have been complemented by archaeometric analyses aimed at clarifying aspects related to clay sources, and to the type, shape, size, and quantity of non-plastic materials in pottery (van As et al., 2006; Dimache & Haită, 2015; Ignat et al., 2019; Koutouvaki et al., 2021; Stoicescu et al., 2023). While these studies have revealed traditions and changes in tempering practices at site level, there remains a lack of sufficient data to thoroughly investigate these technological features on a large time scale over a long time span and across a region that ranges from the Carpathians to the Danube.

## **MATERIALS AND METHODS**

### **Materials, contexts, and chronology**

The analysis of qualitative, quantitative, and semi-quantitative data on pottery inclusions from existing publications, combined with unpublished data from ten sites (twelve levels), includes the microscopic investigation of three assemblages from the Gumelniţa tell site and macroscopic information obtained from ten pottery assemblages. Overall, the data came from twenty sites (thirty-two levels) located between the river Olt in the west, the Carpathian Mountains in the north, the Măcin Mountains in the east, and the river Danube in the south (Figure 1). Microscopic examination was conducted on 310 samples from eleven sites or levels (Supplementary Material Table S1), while 30,836 sherds from twenty-three sites or levels were examined macroscopically (Supplementary Material Table S2). Both the published and unpublished assemblages came from domestic contexts, mostly pits and a small part from dwellings.

Absolute chronology is based on published (Thissen, 2014; Opriş et al., 2017; Lazăr et al., 2020; Ştefan, 2021; Popescu et al., 2023) and unpublished calibrated radiocarbon dates, together covering fifteen sites or levels (Supplementary Materials Figure S2 and Table S3). For the remaining sites or levels, chronology was estimated (marked in grey in Supplementary Material Tables S1–S2) by comparing vessels, primarily their shape and decoration (Supplementary Material Figure S1), with pottery from securely radiocarbon-dated sites. Combining all the information from relative and absolute chronology, the current study covers three periods, three cultural traditions, and eight phases between 5400 and 3800 BC (Table 1).

Grog and its identification

Grog, a commonly used pottery tempering material (Rice, 1987), is defined as ‘any fired-clay product that is crushed and utilized as an aplastic in the pottery’s clay’ (Porter, 1964: 521), known worldwide in various contexts, from Neolithic to modern times (Holmqvist, 2021). It can be identified by the naked eye due to its specific consistency and the angular shape of its grains. Additional factors that aid in its identification include the variety of colours,

dimensions of the grains, and distribution within the clay matrix (Figure 2). Usually, these characteristics make it possible to identify grog-tempered pottery, even without microscopic analysis. There are, however, instances where grog can be mistaken for natural non-plastic materials such as argillaceous rock fragments or iron oxides (Szakmány et al., 2019). Petrological and microscopic analyses (Whitbread, 1986) can help reduce or eliminate this risk. Elisabeth Holmqvist (2021) provides a comprehensive overview of grog added to archaeological ceramics, highlighting key characteristics such as angular or irregular grain shapes, narrow shrink-rim/void, close bonding with the host matrix, contrasting microstructure alignment with the host fabric, different microstructure from the host fabric, irregular grain size compared to argillaceous rock inclusions (e.g. mudstone), and frequent occurrence and even distribution in the host fabric (Figure 3).

RESULTS

Microscopic analysis of tempered pottery

The microscopic characterization of pottery constituents observed in thin sections is a classic archaeometric method of ceramic

**Table 1.** Periods, cultures, phases, and chronology of pottery traditions in southern Romania analysed in the current study (see Petrescu-Dimbovița & Vulpe, 2001 for local terminology; Supplementary Materials Figure S2 and Table S3 for dating).

Periods (Middle and Lower Danube)				
Romania/Bulgaria	Serbia/ Hungary	Cultures (Romania/Bulgaria)	Phases (southern Romania)	General chronology
Middle Neolithic	Middle Neolithic	Dudeşti-Karanovo III Boian-Gradeshnitsa- Karanovo IV–V	Fundeni/Cernica Bolintineanu Giuleşti	5400–4900 BC 5300–5000 BC 5200–4800 BC
Early Chalcolithic	Late Neolithic		Vidra Spanţov	5000–4600 BC 4850–4500 BC
Middle Chalcolithic	Early Chalcolithic	Gumelniţa-Kodjadermen- Karanovo VI	A1 A2 B1	4600–4350 BC 4600–4200 BC 4400–3800 BC





**Figure 2.** Rim sherd of grog-tempered pottery from Berceni-Site 12, Boian-Giulești phase.

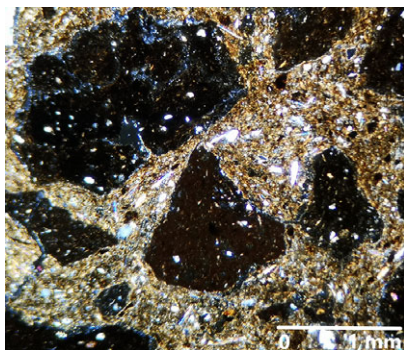
analysis. It helps identify the quality and quantity of inclusions in the clay matrix, as well as their shape, size, distribution, and transformation during firing (Quinn, 2013). There are few published petrological data on pottery samples from the Middle Neolithic and Chalcolithic periods in southern Romania. Moreover, the existing studies have employed various adapted protocols for analysis, leading to a heterogeneous set of records (e.g. van As et al., 2006; Dimache & Haită, 2015; Ignat et al., 2019; Koutouvaki et al., 2021). Tempers and natural non-plastic materials were not always distinguished, and the results were expressed in various ways, including numbers, percentages, or written descriptions. To normalize and gather all these results in a coherent way for this study, clearly intentionally added inclusions (i.e. dense chaff

and grog) were counted separately, while the rest were counted together (i.e. no temper and other types of inclusions), and expressed as percentages. As noted earlier, data were collected from eleven sites or levels and comprise information on 310 pottery fragments (Supplementary Material Table S1).

The microscopic examination of the thin sections revealed the presence of grog in nearly all the sites or levels analysed, with occurrences ranging from 87.5 to 100 per cent. Notably, the absence of grog and the intensive use of organic tempers was documented at the Middle Neolithic site of Milcovu din Deal and the Chalcolithic sites of Teleor 003 and Măgura-Bran. The latter two sites are located close to one another in the western part of Wallachia.

### Macroscopic examination of tempered pottery

The macroscopic data on pottery inclusions extracted from the literature was obtained by various authors using different recording criteria. Only the results expressed both qualitatively and quantitatively were selected for the present analysis and combined with supplementary data obtained from the investigation of unpublished pottery assemblages from nine sites or levels. To facilitate comparison with the results from microscopic analyses, chaff, grog, and their mixtures were recorded separately, while pottery with no temper or



**Figure 3.** Ceramoclasts (grog) in thin section of a pottery sample from the Gumelnița tell, Gumelnița A2 phase.

with natural inclusions (i.e. sand, pebbles, calcareous concretions) were grouped together.

Overall, data on pottery inclusions from twenty-three sites or levels were collected, comprising over 30,000 sherds (Supplementary Material Table S2). Grog-tempered pottery, either alone or combined with chaff, was identified in varying proportions across seventeen sites or levels. Its presence was minimal or entirely absent at Middle Neolithic sites. Conversely, it was predominant in Early and Middle Chalcolithic contexts, with exceptions noted at the Boian-Spanțov sites in western Wallachia and the Gumelnița A2 site at Carcaliu in north-western Dobrogea.

Despite the prevalence of grog tempering in many areas during the fifth millennium BC, there are distinct regional variations in pottery tempering from western Wallachia to north-western Dobrogea. In western Wallachia, chaff was the predominant tempering agent (Thissen, 2014; Opreș & Ștefan, 2016). In contrast, at the Carcaliu site, mineral tempers such as sand and calcareous concretions were more common, grog being a relatively sparse (Burens et al., 2010). For the remainder of the macroscopically analysed Chalcolithic sites or levels, grog-tempered pottery was predominant, with shares ranging from 51.3 per cent at Căscioarele-Ostrovel to 95 per cent at the Gumelnița tell.

### Kernel density estimation

In addition to the descriptions of shape and decoration used to infer the relative chronology of the finds, brief remarks about the quality of the inclusions observed in the pottery paste were often included in local archaeological studies. Consequently, qualitative and quantitative descriptions of the composition of the ceramic fabrics were often short and subjective, reflecting the individual experience

and objectives of the archaeologists. Anthropogenic inclusions, such as grog or chaff, were usually mentioned, whereas natural inclusions like sand, gravel, or calcareous concretions were more rarely specified.

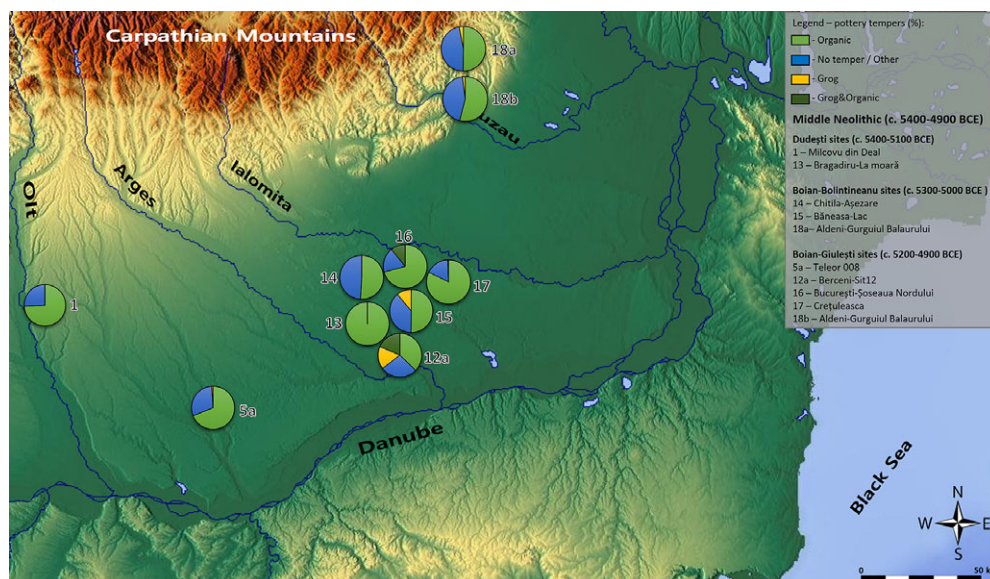
To collect and organize the disparate information gained from publications more systematically, the qualitative statements were converted into quasi-quantitative assessments. This was achieved by approximating the frequency of primary non-plastic inclusions with numerical values ranging from 0 to 4, where 4 denotes predominant, 3 frequent, 2 rare, 1 very rare, and 0 absent or no data.

By synthesizing all the available data, including sites where both qualitative and quantitative data were available (Supplementary Materials Tables S1–S2), a comprehensive dataset was compiled for 103 Neolithic and Chalcolithic sites or levels from the Romanian Lower Danube region (Supplementary Material Table S4). The analysis integrated the values for grog frequency with chronological and chorological data into a geospatial model using kernel density estimation (or KDE; Baxter et al., 1997; Sayer & Wienhold, 2013) within QGIS open source software. The density simulations were conducted at conventional ranges of 20, 50, and 100 km, the most relevant results being obtained at the 50 km range (see below). This approach allowed for a nuanced understanding of the origin, paths of diffusion, and prevalence of grog-tempered pottery across different temporal and spatial contexts.

## DISCUSSION

### Emergence and dispersal of grog-tempered pottery in southern Romania

Given that chaff-tempered pottery dominated the Early Neolithic assemblages in the



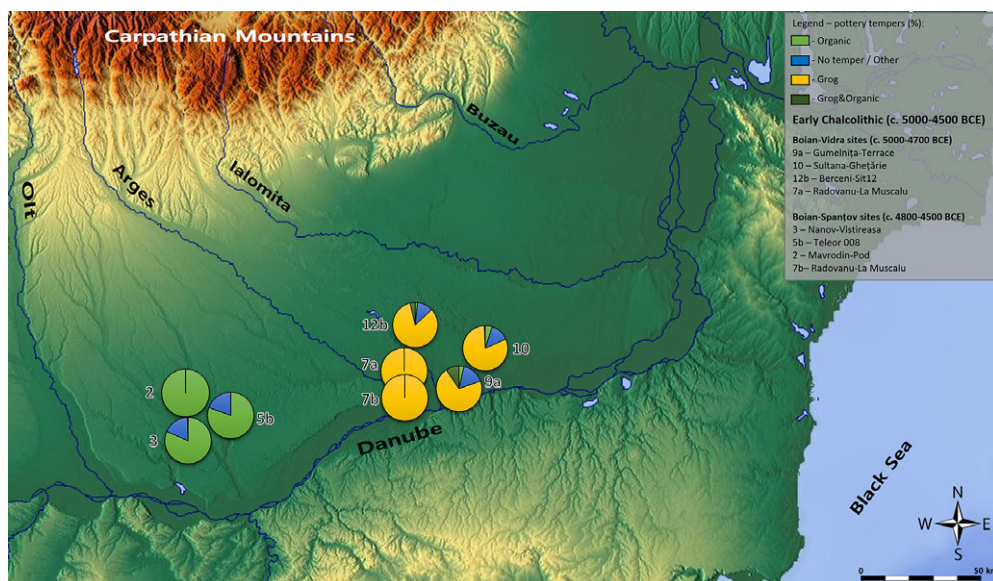
**Figure 4.** Map of south-eastern Romania with locations of Middle Neolithic (c. 5400–4900 BC) sites with qualitative and quantitative data on pottery tempers expressed as pie charts (base map: <https://maps-for-free.com>).

Middle and Lower Danube areas (Spataro, 2019), the emergence and gradual spread of grog-tempered ceramics beginning in the Middle Neolithic signifies a genuine technological change and innovation (Spataro, 2014). However, based on the data collected in southern Romania, grog-tempered pottery did not appear at the onset of the Middle Neolithic, as all pottery produced in the Dudești tradition (see Table 1 for chronology) was exclusively tempered with organic material (Comșa, 1987; Ștefan, 2021). Our data suggest that the first use of grog occurred after 5300 BC, initially appearing in small quantities at Boian-Bolintineanu sites in central and northern Wallachia. Conversely, at another contemporary site in the same area, Chitila-Așezare, chaff tempering remained the norm and grog is absent. Towards the end of the sixth and the beginning of the fifth millennium BC, during the second phase of the Boian culture (Giulești), grog became more consistent, although its frequency remained low, ranging between 0.5 and 35 per cent,

and it was often mixed with vegetal matter. This suggests a gradual and regionally variable adoption of grog-tempered pottery in southern Romania, reflecting the complex dynamics of technological innovation and diffusion at the end of Middle Neolithic (Figure 4).

Beginning in the Early Chalcolithic and continuing until the end of the Middle Chalcolithic, grog tempering appears to have been fully adopted by potters over a broad area between the Danube, the Carpathians, and the Black Sea, with the exception of the western region where chaff tempering was predominant and grog began to be frequently used only at the end of the Chalcolithic (Figures 5–7). In contrast to the Middle Neolithic, when chaff-tempered pottery was prevalent and the introduction of grog-tempered pottery was slow and gradual, the widespread use of grog tempering within Boian-Vidra sites during the first part of the fifth millennium BC signifies a substantial technological shift, corresponding to other major





**Figure 5.** Map of south-eastern Romania with locations of Early Chalcolithic (c. 5000–4500 BC) sites with qualitative and quantitative data on pottery tempers expressed as pie charts (base map: <https://maps-for-free.com>).

changes during this period, such as the emergence of tell-type settlements north of the Danube, the spread of early copper objects, pigments, and a diverse array of new objects of personal adornment made from exotic materials (Popovici, 2010; Opreș et al., 2022).

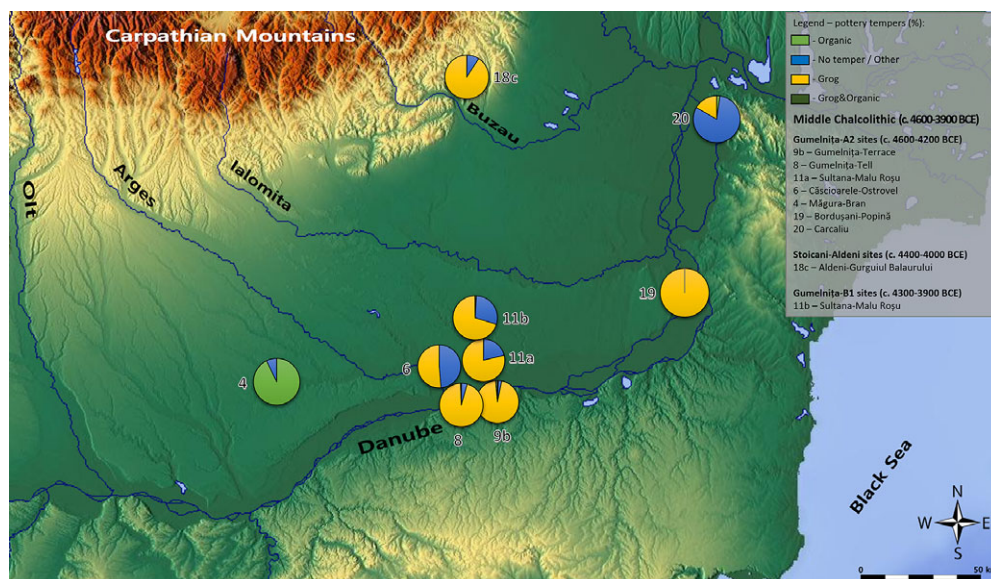
These changes can be linked to a new wave of population coming from the south at the beginning of the fifth millennium BC, as suggested by genetic studies on limited samples (Hervella et al., 2015). This influx may have introduced different technological practices and contributed to the regional variability observed in the archaeological record. The core area of grog-tempered pottery north of the Danube was in southern and central Wallachia for almost the entire fifth millennium BC. This region is also suggested as one of the primary centres where the Kodjadermen-Gumelnita-Karanovo VI culture emerged in the early fifth millennium BC. From this core area, the culture spread east, west, and north, driven by rapid demographic growth (Popescu et al., 2023).

This suggests a strong correlation between the demographic dynamics and the spread of technological innovations, such as grog-tempered pottery, in the Lower Danube region during this period.

The second part of the fifth millennium BC marked the beginning of the decline of the flourishing Chalcolithic civilizations in the Lower Danube area. Within a few centuries, an almost two-millennium-long lifestyle ceased in the region (Reingruber & Thissen, 2009), although some enclaves remained resilient until the beginning of the fourth millennium BC (García-Vázquez et al., 2023; Popescu et al., 2023). Based on the quantified data in this study, the use of recycled ceramics as pottery temper appears to have continued until the end of the Chalcolithic period (Figure 6), as observed in the final habitation layers at tell-type sites such as Sultana-Malu Roșu and Aldeni-Gurguiul Balaurlui.

The semi-quantitative data collected from publications further illustrate this picture, showing that the use of grog diminished during



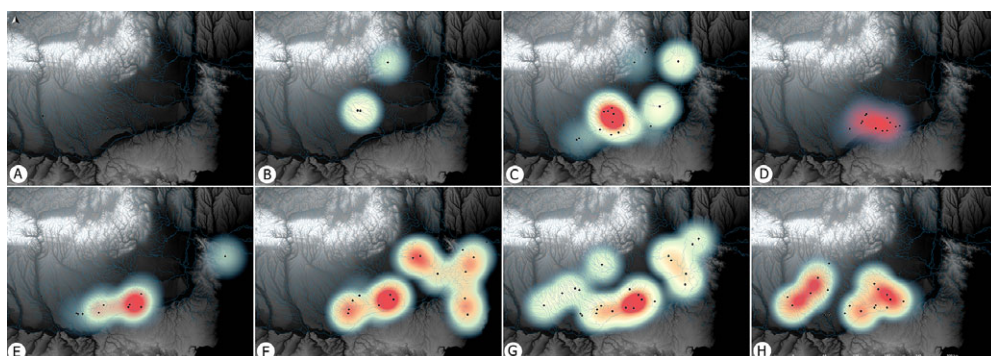


**Figure 6.** Map of south-eastern Romania with locations of Middle Chalcolithic (c. 4600–3900 BC) sites with qualitative and quantitative data on pottery tempers expressed as charts (base map: <https://maps-for-free.com>).

the Middle Chalcolithic in eastern Walachia and Dobrogea and that it was replaced by natural mineral tempers such as sand or pebbles. Meanwhile, grog tempering spread to the west, in an area where organic tempers had been predominant during the Middle Neolithic and Early Chalcolithic (Figure 7).

### Some thoughts on the emergence and spread of Neolithic grog-tempered pottery in south-eastern Europe

In Bulgaria, the examination of ceramics from several eastern Balkan sites indicates a clear predominance of chaff and an absence



**Figure 7.** Heatmaps of grog-tempered pottery frequency in southern Romania generated by KDE at 50 km range (for data, see Supplementary Material Table S4). Cultures/phases: A) Dudești; B) Boian-Bolintineanu; C) Boian-Giulești; D) Boian-Vidra; E) Boian-Spațov; F) Gumelnița A1; G) Gumelnița A2; H) Gumelnița B1. Legend: red = predominant; orange = frequent; yellow = rare, green = very rare; no colour = absent.

of grog in Early Neolithic assemblages (Spataro et al., 2019; Dzhanfezova, 2021). During the Middle Neolithic, grog usage was minimal (Suvandzhiev, 2019), while in the Chalcolithic period, there were numerous mixtures of mineral tempers, with grog being used variably but never predominantly (Georgieva, 1998; Merkyte et al., 2005; Chernakov, 2008; Parvanov, 2021; Popova & Parvanov, 2023). A comprehensive study focused on the evolution of cooking pots in present-day Bulgaria and Greece over five millennia (Dimoula et al., 2022) identified grog only in two Chalcolithic sites north of the Balkan Mountains, while south of the mountains grog was not a preferred temper during the Neolithic and Chalcolithic periods. All this scattered data highlights the variability and regional specificity of pottery tempering practices in the eastern Balkans, making cross-regional comparisons challenging.

In the search for the origins and dispersal of grog tempering, my attention shifted further to the west and north-west, encompassing the central Balkans, Serbian Carpathians, Banat, Transylvanian Plateau, and the Great Hungarian Plain, where data on pottery tempering is more plentiful (excluding Oltenia, where useful data are missing). By adopting a broader geographical perspective, it should be possible to gain a more comprehensive understanding of the technological transitions and cultural exchanges that influenced pottery production across these interconnected regions. Indeed, they witnessed radical changes in tempering practices during the late sixth and fifth millennia BC (Kreiter et al., 2013; Spataro, 2014, 2017; Hofmann, 2020; Vuković, 2020).

The shift from organic to mineral tempering and the gradual emergence of grog-tempered pottery is evident in the Early Vinča assemblages from the central and western Balkans (Amicone et al., 2020; Hofmann, 2020), as well as the Transylvanian

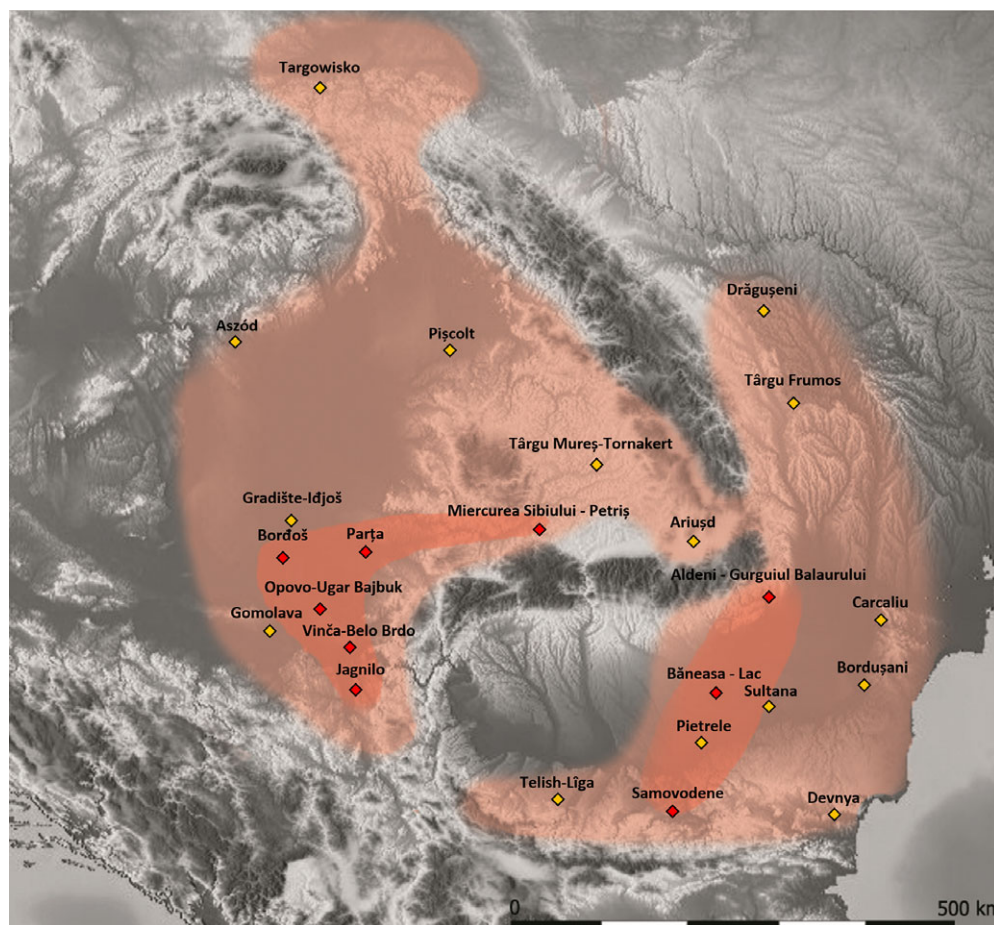
Plateau (Suciu, 2009; Spataro, 2014), within a timeframe ranging from 5350 to 5025 BC, a time that is partly contemporaneous with the slow introduction of grog in the Romanian Lower Danube area and the eastern Balkans. Given that a demographic shift and migration from the south is likely to have occurred during this period (Hervella et al., 2015; Porčić, 2020), one explanation for the change in pottery tempering in the central Balkans could be that these new trends were specific to, and gradually imposed by, putative southern newcomers. Indeed, mineral tempering was a common trait of the Middle and Late Neolithic assemblages in Thrace, Macedonia (Yiouni, 1995; Fidanoski, 2009; Saridaki et al., 2019), and north-western Anatolia (Thissen, 2008; Çilingiroğlu, 2012; Peloschek, 2017), while chaff tempering was rare (unlike in the Middle and Lower Danube areas) (Papadakou et al., 2021). Grog-tempered pottery, on the other hand, is not noted as a particular characteristic in these regions. This suggests that one of the new trends in pottery technology that originated in the south during the second half of the sixth millennium BC involved replacing chaff tempering with mineral temper and that this became rapidly prevalent within Early Vinča assemblages (Spataro, 2014; Vuković, 2020). The introduction of mineral tempering provided a foundation for the development and adoption of grog, reflecting broader processes of technological adaptation and cultural exchange. Thus, while mineral tempering can be seen as a technical feature imported from the south, grog tempering is thought to represent a local invention within the pottery traditions of the Middle and Lower Danube area, signifying a dynamic interplay between external influences and indigenous innovation during the Neolithic period.

Based on the available data, there are at least two areas where grog-tempered pottery was gradually introduced between 5350 and 4800 BC: one in the central Balkans within

the Early Vinča sphere, and one in the eastern Balkans and Romanian Plain within the Karanovo III–IV/Boian-Bolintineanu traditions (Figure 8). While there is insufficient data to link these two zones directly and trace the entire path of grog-tempered pottery introduction in the Middle and Lower Danube region, common southern influences on ceramic craft are discernible in both zones, especially among the widely distributed dark burnished wares and the clay figurines, evident in Vinča, Dudeşti, Boian-Bolintineanu, and Karanovo III–IV

earthenware production (Neagu, 2003; Thissen, 2008; Whittle et al., 2016).

After this initial stage, the tempering of pottery with grog spread rapidly in the first part of the fifth millennium BC and during it, replacing chaff and becoming predominant in several regions across the Middle and Lower Danube area and further to the north-west and north-east (Figure 8). This dissemination is visible in various cultural traditions, including Late Vinča in Banat and Vojvodina (Tringham et al., 1992; Mirković-Marić & Amicone, 2019; Amicone et al., 2020;



**Figure 8.** Approximate spatial extent of grog-tempered pottery in south-eastern Europe during the Neolithic and Chalcolithic (dark orange = emergence areas; light orange = areas of spread), and the main sites associated with this tradition (dark orange = c. 5300–4800 BC; light orange = c. 4800–4300 BC) (base map: <https://maps-for-free.com>).



Hofmann, 2020), Tisza, Herpály, and Lengyel in the Great Hungarian Plain (Kreiter et al., 2017, 2022), Alföld Linear Pottery, Pişcolt, and Malice in the northern Carpathian Basin and Upper Silesia (Kadrow & Rauba-Bukowska, 2017; Kadrow, 2020; Rauba-Bukowska, 2021), Tiszapolgar in Transylvania and Banat (Diaconescu, 2009), Ariuşd in the eastern Carpathians (Sztáncsuj, 2015), Pre-Cucuteni and Early Cucuteni in Moldova (Ellis, 1984, 2005; Marinescu-Bîlcu et al., 2000), and Late Boian and Gumelniţa in Wallachia, Dobrogea, and northern Bulgaria (Oprîş et al., 2017; Dimoula et al., 2022; Stoicescu et al., 2023).

The rapid spread of grog tempering in the fifth millennium BC over a huge area reflects not only the technological adaptability and innovation of its prehistoric communities but also the intricate web of interactions and exchanges. However, there remained some enclaves, such as western Wallachia, where chaff-tempered pottery predominated during the entire Neolithic and Early Chalcolithic periods, despite the shape and decoration of vessels being clearly influenced by broader cultural trends over time. A similar situation, with chaff used in isolation during the first part of the fifth millennium BC, exists in the Great Hungarian Plain and has been interpreted as the persistence of an Early/Middle Neolithic tradition over several generations (Gyucha et al., 2024). As for central Transylvania, mineral tempers were dominant during the Early Chalcolithic, but grog was present in small quantities in ceramics analysed by Oprîş et al. (2015). This regional variability underscores the complexity of technological and cultural diffusion processes, highlighting how local traditions could persist even amid widespread technological shifts.

### Function and social context of grog-tempered pottery

The gradual adoption and wide spread of grog-tempered pottery during the Neolithic

and Chalcolithic periods as a pan-cultural technological tradition in the Middle and Lower Danube Basin requires some explanation. In contexts where similar behaviours have been noted, functional explanations have prevailed because they highlight the practical benefits of this tempering method, but social and symbolic features have also been recognized (Merkyte et al., 2005: 85; Holmqvist, 2021).

From a functional perspective, it is well known that adding grog to the ceramic paste has several advantages. Grog helps prevent the formation of cracks during drying and firing and strengthens resistance to mechanical and thermal shocks (Rice, 1987; Holmqvist, 2021). This increased durability would have made grog-tempered pottery particularly suitable for everyday use, cooking, and storage, which may explain its widespread adoption and persistence over time. Whatever the reason, in most instances no strong correlation between a vessel's function and the presence of grog has been established. This suggests that the successful adoption of grog tempering was not solely influenced by function, and that we should consider social and symbolic explanations for the broader cultural implications of using grog-tempered pottery. The association between long-term tell-type settlements in southern Romania and grog tempering (Figures 5 and 6) may be an indication of a symbolic value carried by grog, which could include the ideological significance and social meaning of the object's previous life (Holmqvist, 2021).

The selection of the same temper over many generations suggests that the choice was a product of cultural learning (Spataro & Meadows, 2013), reflecting social identity, technological knowledge, and cultural traditions. These interpretations highlight that technological choices are often intertwined with social practices and cultural values (van der Leeuw, 1993). Social identity of the potters, as reflected in pottery tempers, is also emphasized by the continuity and resistance



to change of the chaff tempering encountered in the western Walachian assemblages identified in this study.

Regardless of the explanation—whether functional, social, economic, symbolic, or more probably a combination of these factors—prehistoric communities that recycled old pottery as grog effectively removed a substantial part of their ceramic assemblages from the archaeological record. This practice of recycling pottery not only highlights the resourcefulness and sustainability of these communities but also poses challenges for archaeologists attempting to understand the full scope of ceramic production and usage in ancient societies.

## CONCLUSION

This study provides an analysis of the development and dissemination of grog-tempered pottery in the region between the Danube and the Carpathians in a south-eastern European context. Initially produced towards the end of the sixth millennium BC during the Middle Neolithic, grog-tempered pottery became predominant in the Early Chalcolithic. Its distribution suggests a Balkan origin, with a gradual expansion to the north and east. Despite this spread, the core of this technological tradition remained in central and southern Walachia throughout the fifth millennium BC.

The persistence of grog as the main temper type at tell sites occupied over the long term, from the beginning to the end of their occupation (*c.* 500 years), reflects a strong local and regional tradition. Concurrently, the Early Neolithic tradition of tempering pottery with chaff continued into the Middle Neolithic and Early Chalcolithic in western Walachia, even though vessel shapes and decoration were shared with sites where tempering with grog was standard. The sustained use of specific recipes for making ceramics suggests population

continuity in these areas, with clay preparation techniques being passed down through generations even as the aesthetic aspects of pottery changed.

The data gathered suggests that grog-tempered pottery across the Middle and Lower Danube regions began to be made in two initial core areas—in the central Balkans (Early Vinča tradition) and in the eastern Balkans and Wallachia (Karanovo III–IV and Boian-Bolintineanu traditions)—and that it then gradually spread throughout the fifth millennium BC, up to the northern Carpathians. As for the practice of ceramic recycling as grog, it attests to both advanced technological knowledge and significant social dimensions, including aspects of identity, kinship, and ancestry. Overall, this study illustrates the intricate interplay between technological innovation and social traditions in shaping the cultural history of our region.

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## SUPPLEMENTARY MATERIAL

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## BIOGRAPHICAL NOTE

Vasile Opriș has conducted multidisciplinary research in joint projects, tracing the provenance, technology, and characterization of prehistoric ceramics and decorative pigments from southern Romania. His one-year fellowship at the Research Institute of the University of Bucharest within its ArchaeoSciences Platform in 2023–2024 allowed him to investigate the practice of grog-tempering pottery during the fifth millennium BC in southern Romania. He is the head of the History and Archaeology Departments of the Bucharest Municipality Museum, participating in fieldwork and post-excavation research of the Chalcolithic tell sites of Sultana-Malu Roșu and Gumelnița.

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*Cette étude concerne l'émergence et la diffusion de la céramique dégraissée à la chamotte dans le sud-est de l'Europe, particulièrement en Roumanie méridionale. Au cours de la seconde moitié du VI<sup>e</sup> millénaire av. J.-C., une zone dynamique entre le Danube et les Carpates favorisa la dissémination de diverses innovations à travers de multiples voies de communication. Parmi ces innovations, la céramique chamottée apparut autour de 5300/5000 av. J.-C. et se répandit au cours du Ve millénaire. Quoique fréquente, les origines, la diffusion et l'ampleur de la dissémination de cette céramique restent peu comprises. L'auteur de cet article vise à retracer et à expliquer l'apparition et la propagation de la céramique chamottée en Roumanie méridionale. En combinant les données recueillies dans les publications avec les résultats de nouvelles analyses macroscopiques et archéométriques conduites sur douze ensembles céramiques provenant de sites du Néolithique moyen et du Chalcolithique ancien et moyen, l'auteur cherche à souligner l'importance de la première céramique chamottée dans le sud-est européen. Translation by Madeleine Hummler*

*Mots-clés:* dégraissant à la chamotte, céramique, technologie, Néolithique, Chalcolithique, Roumanie méridionale

*Diese Studie betrifft die Entstehung und Verbreitung der mit Schamotte gemagerten Keramik in Südosteuropa, besonders in Rumänien. In der zweiten Hälfte des 6. Jahrtausends und während des 5. Jahrtausends v. Chr. entstand eine dynamische Zone zwischen der Donau und den Karpaten, in welcher*

*Innovationen durch mehrere Kommunikationswege eingeführt wurden. Unter diesen Neuerungen erschien die schamottegemagerte Keramik um 5300/5000 v. Chr. und verbreitete sich im 5. Jahrtausend. Obschon sie häufig vorkommt, sind die Herkunft, Ausbreitung und Dichte dieser Ware wenig erforscht. In diesem Artikel wird versucht, den Ursprung und die Ausdehnung dieser schamottegemagerten Keramik in Südrumänien. Durch die Integration von aus veröffentlichten Quellen gesammelten Daten mit neuen makroskopischen und archäometrischen Untersuchungen von Keramiksammlungen aus zwölf mittelneolithischen und früh- und mittelkupferzeitliche Stätten versucht der Verfasser, auf die Bedeutung der ersten schamottegemagerten Keramik in Südosteuropa hinzuweisen. Translation by Madeleine Hummler*

*Stichworte:* Schamotte, Keramik, Technologie, Neolithikum, Kupferzeit, Südrumänien