RAPORT STIINTIFIC

pentru anul IV (2015) de desfasurare a proiectului PN-II-ID-PCE-2011-3-0881

Geoscientific view of ceramic technology: evolution from Neolithic to Byzantine times within Romanian territory (O perspectiva geostiintifica asupra tehnologiei ceramicii: evolutia din Neolitic pana in timpurile Bizantine pe teritoriul Romaniei)

In cursul anului 2015 a continuat prelucrarea materialului ceramic si geologic colectat in 2014 si a mai fost colectat material nou din Epoca Cuprului (situl Pestera Mare Cerisor din Carpatii Meridionali), perioada de tranzitie Epoca Bronzului/Epoca Fierului (sityul Vlaha, Bazonul Transilvanieie), Epoca Bronzului (Silistea, jud. Iasi), Periada Romana si Bizantina (siturile Libida). S-au cartat aflorimentele de argile in jurul siturilor (pe o raza de 15-20 km) si s-au colectat probe. Din materiualul ceramic s-au executat sectiuni subtiri destinate investigatiei microscopice in lumina polarizata. S-au taiat felii milimetrice din care s-au executat sectiuni lustruite cu pasta de diamante destinate studiului la microsonda electronica.

S-au mojarat cantitati diferite de probe (atat ceramica act si roci argiloase) pentru analize de difractie de raze X si analize geochimice prin spectrometrie de masa cu plasma cuplata inductiv. S-au executat analize mai putin obisnuite, cum sunt Fourier spectroscopie Fourier Transform Infrared, Resonnata electronica de spin ([paramagnetica) si interferometrie de scaning vertical. In p[lus s-au obtinut primele rezultate la microsonda cu „emisie de camp” care permite vizualizarea in domeniul micrometrilor a transformarilor termice din ceramica. Interferometria verticala de scanning si microsonda cu emisie de camp sunt prima data aplicate in domeniul ceramicii antice.

Activitatile de rutina din proiect se incadreaza in graficul temporal initial si includ:

- Documentare de teren si bibliografica, colectare si prelucrare de probe de ceramica, Colectare si prelucrare probe de materii prime (argile) din zona siturilor,
- Prelucrare (spalare) probe de argile din zona siturilor,
- Executare de sectiuni subtiri pentru investigatii mineralogice si petrografice Executare de sectiuni subtiri pentru analize de microsonda electronica
- Executare de fotografii la microscopul polarizant
- Participare la manifestari stiintifice internationale si nationale si comunicarea rezultatelor (oral, poster)
- Organizare de sesiuni stiintiifice specifice (ceramica arheologica, arheometrie) la manifestari stiintifice internationale de mare prestigiu
- Publicare de rezultate finale (articole ISI, BDI, capitole in carti, editare volum).

Experimentele cu probe de argila care sunt folosite in prezent pentru obtinerea de ceramica traditionala au confirmat rezultatele anteriare (deja publicate in 2014) si au permis elaborarea unui manuscris trimis spre evaluare.

Publicarea si comunicarea rezultatelor:

A. Lucrari ISI publicate in 2015 (numele membrilor echipei, in bold)

1. **Benea M**., Diaconu V., Dumitroaia Gh. (2014) Preliminary data on Bronze Age pottery from Savesti (Neamt county, Romania). **Studia Universitatis Babes-Bolyai Chemia, LX (1), pp. 89-98.** (ISI journal, I.F. = 0.39; http://chem.ubbcluj.ro/~studiachemia/docs/Chemia12015.pdf)
2. **Ionescu C., Hoeck V., Crandell O.N.,** Šaric K.: Burnishing versus smoothing in ceramic surface: A SEM study. **Archaeometry (2015), 57 (1): pp. 18-26** (ISI

Journal, I.F. = 1.287; doi: 10.1111/arcm.12089; http://onlinelibrary.wiley.com/doi/10.1111/arcm.12089/full)

3. **Crandell O.,** Vornicu D.-M.: Aspects of long distance trade by the Precucuteni Culture. **Transylvanian Review (2015), XXIV** (2), pp. 85-108. ISI journal. http://www.centruldestudiitransilvane.ro/detaliu.aspx?eID=713&t=Review%202015%20-%202035&cat=0

B. Lucrari aflate in review (in evaluare) la reviste ISI

1. **Giurgiu A., Ionescu C**., **Hoeck V**., Tamas T., Roman C., **Crandell O.N**.: Insights into the raw materials and technology used for producing Coppere Age ceramics in the Southern Carpathians (Romania). *Archaeological and Anthropological Sciences* (*Submitted, in review; manuscris nr. AASC-D-15-00160)*. ISI journal. IF = 1.81; http://www.springer.com/earth+sciences+and+geography/journal/12520
2. **Ionescu C**., Berecki S**., Hoeck V**., **Giurgiu A.**: Optical and XRD study of Celtic pottery from Transylvania (Romania): Inferring raw materials and technological constraints. *Journal of Cultural Heritage* (*manuscris no. CULHER-S-14-00446; in evaluare*). Elsevier, ISI Journal, I.F. = 1,111; http://www.journals.elsevier.com/journal-of-cultural-heritage/
3. **Ionescu C.**, **Simon, V.**, **Hoeck, V.**: FTIR study of the phase changes in heated Ca-rich illitic clay. *Vibrational Spectroscopy* (*submitted, in review; manuscris no. VIBSPEC-D-15-00309*); ISI journal, IF = 2.0; http://www.journals.elsevier.com/vibrational-spectroscopy/
4. **Benea M.**, Lazarescu V.-A., Gorea M.: Contribution to the study of Sugeag pottery, Cluj county, Romania. *Studia Universitatis Babes-Bolyai Chemia* (*Submitted, in review*). ISI Journal.

C. Lucrari publicate in reviste din BDI (numele membrilor echipei, in bold)

1. Crandell O.N., Popa C. (2015) The chert quarrying and processing industry at the Piatra Tomii site, Romania. ***Journal of Lithic Studies***, ***2(1), 45-63.*** http://journals.ed.ac.uk/lithicstudies/article/view/1154/1772

D. Lucrari acceptate in reviste de BDI (numele membrilor echipei, in bold)

1. **Crandell O.N.** (2014) Stone tools used in the ceramics production industry. **Journal of Lithic Studies** (*manuscript no. 1134/2014; accepted*).

E. Editare de carti/volume: (numele membrilor echipei, in bold)

1. Mangado X., **Crandell O.,** Sanchez M., Cubero M. (2015) 10th International Symposium on Knappable Materials Abstract Volume, 200p, SERP-Universitat de Barcelona 200 p.

F. Comunicarea rezultatelor la manifestari stiintifice internationale si nationale (numele membrilor echipei, in bold):

6th MINERAL SCIENCES IN THE CARPATHIANS CONFERENCE (MSCC 2015), 16-19 May 2015, Veszprem, Hungary. (http://mscc2015.hu/)

1. **Crandell O.N., Ionescu C., Giurgiu A**., **Simon V.,** Trandafir D.L., Nagy J.G. (2015) Pottery firing technology in the Late Bronze Age & Early Iron Age in NW Romania. *Acta Mineralogica-Petrographica, Abstr. Series,* Vol. 9, Szeged. p. 5.
2. **Crandell O.N., Ionescu C.,** Mirea P. (2015) Tools used in ceramics production during the Neolithic and Chalcolithic: Examples from Teleorman county, Romania. *Acta Mineralogica-Petrographica, Abstr. Series,* Vol. 9, Szeged. p. 6.

3. **Giurgiu A., Ionescu C.,** Zaharia L., Socaciu A. (2015) Mineralogical study of tegulae from Roman Porolissum (NW Romania). *Acta Mineralogica-Petrographica, Abstr. Series,* Vol. 9, Szeged. p. 17.
4. **Ionescu C.,** Berecki S., **Hoeck V., Simon V., Giurgiu A**., Trandafir D.L. (2015) Integrated study on compositional and technological characteristics of Celtic pottery from Transylvania (Romania). *Acta Mineralogica-Petrographica, Abstr. Series,* Vol. 9, Szeged. p. 22.
5. **Ionescu C., Simon V., Hoeck V.** (2015) Effect of temperature on the composition and microstructure of carbonate-rich illitic clay investigated by FTIR. *Acta Mineralogica-Petrographica, Abstr. Series,* Vol. 9, Szeged. p. 23.
6. **Ionescu C., Hoeck V.** (2015) Archaeological ceramics: a geoscientific perspective. *Acta Mineralogica-Petrographica, Abstr. Series,* Vol. 9, Szeged. p. 24.

10th INTERNATIONAL SYMPOSIUM ON KNAPOPABLE MATERIALS, 8-10 Sept. 2015, Balcelona, Spain (http://www.ub.edu/cherts-symp2015/)

1. **Crandell O.N.** (2015) An overview of the knappable stone economy at the Trataria site (Romania). Abstract volume, p. 67.
2. Harwood R., **Crandell O.** (2015) Practical applications of Dekton artificla rock for experimental archaeology and traditional lithic technology. Abstract vol., p. 163.

14th EUROPEAN MEETING ON ANCIENT CERAMICS (EMAC), 24-26 Sept. 2015, Athens, Greece (http://www.emac2015.gr/):

1. **Ionescu C.**, Fischer C., **Hoeck V.**, Luttge A. (2015) A new approach to the surface finishing of ceramic pots: Vertical scanning interferometry. Abstracts vol., pp. 36.
2. **Hoeck V.**, **Ionescu C**., **Simon V., Crandell O.N.,** Rusu-Bolindeţ V. (2015) Raw materials for the ceramic moulds from the Micăsasa workshops (Roman Dacia, 2nd-3rd c. A.D.). Abstracts vol., pp. 101.

3. **Giurgiu A**., **Ionescu C**., Šarić K., Tămaș T., Roman C., **Crandell O.** (2015) SEM study of surface decorations of Neolithic-Chalcolithic ceramic pots from the Cerișor Cave (Southern Carpathians, Romania). Abstracts vol., pp. 130.

SESIUNEA ANUALA "ION POPESCU VOITESTI" (Departamentul de Geologie al Universităţii Babeş-Bolyai), 4 decembrie 2015

1. **Benea M.,** Lazarescu V-A., Gorea M. (2015): Contribuţii la studiul unor fragmente ceramice de la Suceag, judeţul Cluj, România.

F. PREGATIRE/EDITARE DE MANUSCRISE PENTRU PUBLICARE IN 2016:

1. **Ionescu C**., Fischer C., **Hoeck V**., Luttge A. Application of vertical scanning interferometry for the quantification of ceramic ware surface roughness. *Archaeometry*.
2. **Ionescu C., Giurgiu A., Hoeck V.,** Saric K.: SEM study of the surface finishing used for Copper Age ceramics from Southern Carpathians (Romania). *Journal of Cultural Heritage*.
3. **Crandell O., Ionescu C., Giurgiu A.** Pottery firing technology in Iron Age in western Transylvania. *Archaeometria Muhely*.
4. **Ionescu C.**, Topa D. Filed emission microprobe: a new tool for investigating ancient ceramics technology. *Archaeometry*.
5. **Ionescu C.**, **Hoeck V.,** Savu M. Hands modeled of clay at Bronze/iron Age site from Vlaha (Transylvanian Basin, Romania): from what, how and what for were they modeled? *Archaeometry*.

G. ALTE REALIZARI:

G1. Ionescu C.: Curs "Introduction into the mineralogy and petrography of ancient ceramics", Paris Lodron University, Salzburg (Austria), Curs no. 101.104, Noiembrie 2015.

G2. Ionescu C.: Convener, chairperson si membru in Comitetul stiintific international; Organizarea sesiunii de arheometrie la 6th MSCC 6th Mineral Sciences in the Carpathians Conference, Veszprem Hungary, 16-19 mai 2015. http://mscc2015.hu/

G3. Ionescu C.: Convener, chairperson si membru in Comitetul stiintific international la 13th European Meeting on Ancient Ceramics, Athens Greece, 23-26 sept. 2015; http://www.emac2015.gr/

G4. Crandell O.: Convener, chairperson si membru in Comitetul stiintific international si Vicepresedinte al simpozionului 10th International Symposium on Knappable Materials, Barcelona, Spain, 7-12.09.2015. http://www.ub.edu/cherts-symp2015/

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5.12.2015 **DIRECTOR PROIECT**

PROF.DR. CORINA IONESCU

ANEXE:

STUDIA UBB CHEMIA, LX, 1, 2015 (p. 89-98)
(RECOMMENDED CITATION)

PRELIMINARY DATA ON BRONZE AGE POTTERY FROM SĂVEŞTI (NEAMŢ COUNTY, ROMANIA)

MARCEL BENEA[a*], VASILE DIACONU[b], GHEORGHE DUMITROAIA[c]

ABSTRACT. The paper presents the results of the mineralogical and physical analyses carried out on 20 potsherds from Săveşti (Neamţ county, Romania) belonging to Noua Culture. The goal of this investigation was to provide information on the type of temper materials, the way that the vessels were shaped, the temperature and firing conditions. Generally, the colour is homogenous, grey to black indicating reducing atmosphere. Exceptions are three samples with a "sandwich"-type structure and one sample with a yellowish-brown colour that suggest an oxidizing atmosphere during firing. The matrix is relatively uniform, with clasts of various sizes (up to 3-4 mm). Macroscopically, quartz grains, micas, and ceramoclast were identified. Based on microscopic grain size, two types of ceramics can be separated: semifine (lutitic-siltic-arenitic), and coarse (lutitic-arenitic-siltic). Based on the ratio between crystalline *vs.* amorphous phases, microcrystalline-amorphous and amorphous-microcrystalline to amorphous fabrics were described. The presence in some samples of elongated primary pores and the preferential orientation of micas lead to a flow texture. As non-plastic materials (temper), crystalloclasts (quartz, micas, iron oxi-hydroxides, feldspars, epidote, zircon, rarely carbonates), lithoclasts (quartzite, micaschist, gneiss), and ceramoclasts were identified. The X-Ray diffraction analyses confirm the microscopic observations. Some physical characteristics were also measured: the water adsorption values range between 7.17 % and 14.44 %. According to the macroscopic, microscopic and compaction features we estimate the firing temperature of the studied potsherds to be between 850-900°C,

Key words: *archaeometry, Bronze Age pottery, mineralogical and physical analyses, Noua Culture, Romania.*

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Otis Norman Crandell
Diana-Māriuca Vornicu

Aspects of Long Distance Trade by the Precucuteni Culture

The largest category of imported lithics from the Precucuteni settlement is represented by the artefacts made of so called "Balkan flint," a raw material that originates in the Lower Danube region.

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Introduction

The objective of this study was to determine whether lithic artefacts or raw materials were being imported from the Lower Danube region into the Târgu Frumos settlement, in the Moldavian Plain,

The authors would like to express gratitude to Prof. Dr. Nicolae Ursulescu (Alexandru Ioan Cuza University, Iaşi) for providing access to the artefacts (which played an important role during the doctoral studies of Dr. Vornicu). Gratitude is also owed to Prof. Dr. Corina Ionescu (Babeş-Bolyai University, Cluj-Napoca) for providing advice and information concerning the geological raw materials.

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archaeometry

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BURNISHING VERSUS SMOOTHING IN CERAMIC SURFACE FINISHING: A SEM STUDY*

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From the Neolithic up to the present, people have used various methods to improve the surface of ceramic objects. In this study, we look specifically at smoothing and pattern burnishing of ceramics produced today by traditional methods. Optical microscopy and SEM show specific surface changes. Smoothing results in an irregular surface, which causes diffused reflection of light. Burnishing produces an even and compact surface, which causes specular reflection and lustre. The results can be used to infer methods of surface treatment employed by ancient peoples as well as to help identify the presence of ceramics production centres at archaeological sites.

KEYWORDS: ROMANIA, BLACK CERAMICS, OM, SEM, SMOOTHED SURFACE, PATTERN BURNISH

INTRODUCTION

Since the advent of pottery in Late Palaeolithic to Early Neolithic times—independently invented in different places (Shelach 2012); for example, *c.* 20,000 BP in South China (Wu *et al.* 2012)—potters have tried to ornament their wares. Over time, they have developed several methods, including smoothing, polishing and burnishing. The latter gives to the ceramic objects a lustrous surface similar to that obtained by coatings such as some slips, paints and particularly glazes (Maggetti *et al.* 1981; Gliozzo *et al.* 2004; Memmi 2013).

A comprehensive definition of burnishing is provided by Berg (2008): '. . . the use of a hard, smooth object (e.g. stone, wood or bone) to rub the vessel surface at the leather hard stage often resulting in narrow parallel facets. By compressing the clay, burnishing creates a characteristic luminous shine.' Burnishing can be either plain—that is, covering the whole surface of the ceramic object—or patterned—that is, restricted to decorative lines. Pattern burnishing has been used since the Neolithic (e.g., Mellaart 1967; Demoule and Perlès 1993; Tsuneki and Miyake 1996). It takes place after hand- or wheel-shaping and the drying of the objects up to the so-called 'leather-stage' (Rutter 1975; Froh 2004; Berg 2008; Iserlis 2009). The implement materials include mostly stones, but bone, wood, ceramics, metal and shells are also used. The stone tools are water-worn pebbles (Stahl *et al.* 2008; Fowler 2011; Murphy and Poblome 2012), lithic pestles (Deal 1988), flint chips (Méry *et al.* 2007; Iserlis 2009) or agate pieces (Hall 1889; Clarke 2012). They require a smooth, slightly convex or flat surface and should be large enough to be easily grasped.

So far, not much is known about the small-scale effects of surface finishing on a crude ceramic body. By means of the famous 'Marginea black ceramics' (MBC; Fig. 1 (a)) produced nowadays

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Insights into the raw materials and technology used for producing Copper Age ceramics in the Southern Carpathians (Romania)

--Manuscript Draft--

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	Romanian Ministry of Education and Research (UEFISCDI/CNCS) (PN-II-ID-PCE-2011-3-0881) — Corina Ionescu, Volker Hoeck, Otis Crandell
Abstract:	The Copper Age Coţofeni culture occupied a large territory which covers present day W Romania, NE Serbia and NW Bulgaria. These people lived in settlements located on hill slopes and river terraces, as well as in caves. Their hand modeled ceramic pottery is richly ornamented by incisions, incrustations, "lentil bean" appliqués and ridges as well as by burnishing. Potsherds found in the 'Peştera Mare de la Cerişor' (i.e. the 'Great Cave of Cerişor') located in the Paleozoic crystalline limestone (Southern Carpathians, Romania) were studied in terms of mineralogy and petrography by OM, XRD and EMPA. The sherds consist of a Fe-rich illitic matrix embedding quartz, K-feldspar, muscovite, plagioclase, biotite, chlorite, various heavy minerals, metamorphic, magmatic and sedimentary lithoclasts, as well as soil concretions and ceramoclasts. The matrix is microcrystalline to almost amorphous, and reflects changes due to firing at temperatures ranging from ~700 °C up to ~900 °C. Quaternary silty loam from the cave and Miocene mudstones from the area were analyzed by XRD in order to determine the provenance of the raw materials.
Suggested Reviewers:	Alessio Langella, Prof. Dr.

The chert quarrying and processing industry at the Piatra Tomii site, Romania

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Abstract:

Fieldwalking surveys in 2007 and 2008 revealed a moderate sized settlement on Piatra Tomii Hill (Alba County, Romania) which was considered of interest because of its location on top of a natural source of chert, and the large amount of chert artefacts found on the surface. In 2009 the site was excavated during which one of the objectives was to learn more about the chert mining and processing at the site. The ratio of artefact types and lack of use-wear suggests that not only was raw material being extracted at the site, but tools were also being produced locally before being exported. The 2009 excavations also revealed what appear to be the remains of pit quarrying and possibly fire cracked limestone and debris. These finds provide technical insight into potential chert extraction techniques utilised in the Late Chalcolithic and Early Bronze Age. As well, this is as yet the only reported settlement in the Transylvanian basin involved in chert extraction (either quarrying or mining). Given the settlement's affluence, especially considering its relative isolation, it is likely that the chert industry here was important to communities in the vicinity. Indeed artefacts found at contemporary sites in the Mureş Valley appear to have been made from the same or a similar chert. This paper gives an introductions to the site, describes the artefacts and features found there and provides possible interpretations regarding the processing and export industry, as well as the methods of extracting the raw material during this period.

Keywords: chert; quarrying; lithic artefacts; Chalcolithic; Romania

1. Introduction

One of the main focuses of the excavations was to learn more about the chert industry at the settlement. In particular, there was an interested in how the material was being extracted and how it was being processed afterwards. For this, the research at this site has investigated areas potentially linked to chert extraction. There was also an interest in the general lives of the people who inhabited the settlement so a dwelling was partially excavated. Excavations of the dwelling introduced a new form of Coţofeni dwelling architecture which also became a topic of interest.

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Title: **FTIR study of the phase changes in heated Ca-rich illitic clay**

Article Type: Research paper

Keywords: Ca-rich illitic clay; Thermal treatment; FTIR; Ceramics

Corresponding Author: Prof. Corina Ionescu, Ph.D.
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Order of Authors: Corina Ionescu, Ph.D.; Viorica Simon, Prof.Dr.; Volker
Hoeck, Prof.Dr.

Abstract: Fourier transform infrared (FTIR) spectroscopy was used to identify the specific changes occurring in Ca-rich illitic clay, thermally treated between 400 and 1200 °C. The clay is a mixture of illite, muscovite, quartz, calcite, feldspar, chlorite, dolomite and Feoxyhydroxides.
A progressive flattening of the FTIR signals is characteristic for all temperatures higher than 700 °C. Some signals are
shifted, others diminish or even disappear and new signals occur at certain temperatures. The spectra were deconvoluted in order to determine
the destruction of primary minerals of the clay and gradual appearance of
new phases such as metakaolinite, metasmectite, lime, hematite, wollastonite, gehlenite, feldspar, as well as maghemite, diopside, mullite and glass. These newly-formed phases occur either simultaneously
or sequentially, proving instable equilibrium conditions and coexistence
of many compositionally different minerals. The specific mineralogical assemblages, associated with temperature intervals, may be used in inferring technological conditions for ancient ceramic artifacts.
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Stone tools used in the ceramics production industry

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Abstract:
This paper focuses on Neolithic and Chalcolithic tools with uses in the pottery production industry and found within the territory of modern day Romania. The artefacts have here been grouped based on their involvement in various stages of pottery production: a) quarrying of the raw claystone (picks); b) processing the raw materials (mortars and pestles); and c) surface finishing (smoothers, polishers). The surface of the tools was examined by non-destructive surface methods (handheld loupe, stereo microscope) with the aim of further determining their function and whether they were likely used in the ceramics industry.
This study provides examples of specific stone tool types and illustrates characteristics useful for identifying their use. It also shows the possible *chaîne opératoire* of pottery produced during the Neolithic and Chalcolithic within the study area.
Keywords: ceramics; stone tools; Neolithic; Chalcolithic; Romania

1. Introduction

The production of ceramic pottery involves numerous steps, each of which requires different tools. Many studies focus on pottery, sometimes as tools from a functional point of view, sometimes as cultural markers used to date sites, and sometimes from the point of view of the raw material of which they are composed. The steps involved in pottery production are often studied based on the remains of the pottery itself with only minor mention of the tools used in its production. This paper presents an overview of tools used in the production of ceramic during the Neolithic and Chalcolithic tools found within Romania which may have been used in the ceramics production industry.

2. Tool typology

The tools studied have here been grouped based on their possible usage in various stages of pottery production. We start with those which may have been used to quarry the raw clay, such as picks. We also describe tools such as mortars and pestles involved in processing the raw materials – particular by coarse and fine grinding. Finally, we come to surface finishing tools.