TECHNICAL INNOVATION AND PRACTICE IN ENEOLITHIC AND BRONZE AGE ENCRUSTED CERAMICS IN THE CARPATHIAN BASIN, MIDDLE AND LOWER DANUBE

Joanna Sofaer and Stephen Roberts

Encrusted ceramics are a visually striking group of objects, found in very large numbers in a wide range of prehistoric cultural units throughout Europe. They are particularly prevalent in Eneolithic and Bronze Age groups within the Carpathian Basin and along the Middle and Lower Danube (Kiss 2013). In this region they form an important, long-standing tradition that transcends individual cultural units, although their production does not appear to have been continuous over time (Kos et al. 2015, Tasić 2003-2004). The apparent similarity between these ceramics, based on their distinctive mode of inlayed decoration, contrasts with the variability in vessel shapes and decorative motifs (**Figure 1**). This has led to substantial, long-standing discussion regarding the significance of such similarities and differences and how these should be interpreted in terms of relationships between cultural units (Bóna 1975, Dimitrijević 1979, Kiss 2012, Reich 2006, Şandor-Chicideanu 2003, Šimić 2000). Although it has been argued that the River Danube may have formed a natural route along which the use of encrusted ceramics developed, the nature of the relationship between different contemporary groups is frequently unclear (see Kiss 2012, Tasić 2003-2004).

The earliest encrusted ceramics in the region are found at Eneolithic Kostolac sites (3300-2700 BC) and their immediate successor the Vučedol culture (2900-2400 BC) (Balen 2005, Dimitrijević 1977-78; 1979, Durman 1988). They are less prevalent in the Early Bronze Age but appear in large numbers during the Middle Bronze Age. They are also found in the late Early Bronze Age Kisapostag culture (Črešnar 2010), the precursor to the Transdanubian Encrusted Pottery culture of the Hungarian Middle Bronze Age (2000-1500 BC) named for the prevalence of encrusted vessels. However, elaborately decorated inlaid ceramics feature to a greater or lesser extent in the ceramic assemblages of several other contemporary cultural groups in the Carpathian Basin and along the Middle and Lower Danube. These include the Szeremle / Dalj-Bijelo Brdo group in eastern Croatia, which is frequently understood as the southeast extension of the late phases of the Transdanubian Encrusted Pottery culture (Kiss 2012; 2013, Šimić 2000, Tasic 2003-2004), and the Dubovac-Žuto Brdo and Gârla Mare culture which form a more or less continuous unit in the southeast of the Panonnian Plain in Serbia and Romania (Şandor-Chicideanu 2003). Inlaid ceramics are also found further north along the Danube in Vatya sites in Hungary. In the Vatya sites they are less abundant and have frequently been assumed as imports from their Transdanubian Encrusted Pottery neighbours. Recent work has, however, demonstrated a more complex picture with both imports and local production of inlaid ceramics at Vatya sites and in other contemporary cultural units (Sofaer / Mihelić / Roberts / Williams 2013, Bodnar et al. 2014).

In this paper, rather than reiterate classifications and descriptions of motifs we focus on technical innovation in the practice of making the inlays themselves and their link to social identity. In common with many other objects, while typo-chronological studies of encrusted wares have traditionally taken primacy in the identification of culture-specific forms, questions remain regarding the role of practice and the use of materials. There is a risk of building rather simplistic models of cultural identity while ignoring the ways that people engage with materials on practical and imaginative levels in order to make objects. Understanding such potential subtlety in the relationship between objects and identity requires a critical engagement with the concept of typology (Sørensen 2015) alongside contextually sensitive appreciation of creativity in practice, since this underpins innovation in material culture (Sofaer 2015).

Given that the inlays ostensibly look very similar they offer a particular opportunity to explore how people differently addressed the problem of their manufacture. We focus on practice by examining choices of materials, the ways these were combined as 'recipes' used for the inlays, and the preparation of these materials. In addition, we consider the tools employed to make the beds in which the inlays sat, 'techniques of the body' (Mauss 1935) used to manipulate the tools, and methods used to fix the inlays to individual ceramic vessels.

Whilst there have been sporadic analyses of the composition of inlays (Kos / Posilivić / Durman 2013, Roberts / Sofaer / Kiss 2007), there has been no detailed synchronic or diachronic study of the practice of making encrusted wares in the region. We present the first comparative analysis of encrusted ceramics from a range of cultural units using x-ray diffraction (XRD) and Scanning Electron Microscopy (SEM) to examine how aspects of practice relate, or not, to established chronological and spatio-typological differences in decoration in Eneolithic and Bronze Age cultural groups.

METHODS

A total of 91 inlaid vessels from 26 sites (**Figure 2a and b; Table 1**) were collected and analysed including Eneolithic Kostolac samples from the early phases of the tell settlement at Vučedol and Classic Vučedol samples from the eponymous site of Vučedol and the tell settlement of Sarvaš in the Vučedol 'heartland'. Bronze Age samples come from sites representing a range of cultural units with encrusted ceramics in the Carpathian Basin and along the Middle and Lower Danube. Our Transdanubian Encrusted Pottery samples come from 6 sites, including both cemeteries and settlements; this material was previously the subject of a pilot project investigating the composition of inlays (Roberts / Sofaer / Kiss 2007). The Szeremle / Dalj-Bijelo Brdo sherds come from 13 sites, both cemeteries and settlements. Gârla Mare material comes from 4 sites, most of which are cemeteries, reflecting a bias towards the greater investigation of these contexts for this cultural unit. Vatya samples come from the large tell settlement of Százhalombatta where there is a rich, well-documented pottery assemblage

(Budden and Sofaer 2009). For all the samples discussed here, vessel fabrics correspond well both with other contemporary vessel types from the same site and with the local geology of the site at which they were found, suggesting local production.

Inlay samples were analysed using a LEO1450 variable pressure scanning electron microscope (SEM) equipped with a backscattered electron detector and quantitative PGT energy dispersive X-ray microanalysis system. Operating conditions were 20 kV and 19 mm working distance. X-ray diffraction (XRD) data were collected using a Phillips XPert Pro diffractometer equipped with a Cu Kα(λ= 1.54056 Å) radiation tube, run from 2° to 76° (2 θ) at a step size of 0.02° (2 θ) at 1.2°(2 θ per minute).

MATERIAL CHOICES AND COMBINATIONS: INLAY COMPOSITION AND RECIPES

The mineralogical composition of the inlays shows distinct chronological and spatial differences in the primary materials used to make the inlays (**Table 2**). The earliest inlays in the region, those belonging to the Eneolithic Kostolac culture, are predominantly made of calcite, one of lime, and in three samples more than 5% of the inlay is composed of quartz. Under SEM the quartz grains are angular consistent with crushing of this material, suggesting it is a deliberate addition to the inlay recipe.

The dominant material used in the majority of the Classic Vučedol inlays is aragonite, a carbonate polymorph, typically found in bivalves, corals and mollusc shells. This aragonitic inlay was sometimes mixed with crushed quartz, typically in a ratio of 10:1; aragonite-quartz. Half the samples with aragonite also contain calcite. Three samples of inlay comprise calcite and quartz only, and therefore resemble the earlier Kostolac recipe. There is no substantial difference between the sites in terms of the primary materials used for inlays. It is, however, notable that two samples from Sarvaš are exceptions to the more general use of aragonite, most likely derived from crushed shell. These are made of hydroxyapatite, the mineral fraction of mammal bone and teeth; one sample is composed of hydroxyapatite and quartz, the other of hydroxyapatite, quartz, and calcite.

In contrast to the Eneolithic inlays, Middle Bronze Age inlays in almost all cultural groups in the Carpathian Basin and along the Middle and Lower Danube were composed of hydroxyapatite, indicating mammal bone as the primary material used for the inlays. This change in the mineral composition of the inlay reveals a distinct chronological shift in the practice of making encrusted ceramics that is particularly striking in the middle Danube (eastern Croatia), where encrusted ceramics were produced in both the Eneolithic and Middle Bronze Age. However, the methods by which the animal bone was combined with other materials, and the degree of variability and consistency in the composition of inlays, shows variation in ‘recipes’ within and between cultural units (**Table 2**).

In the north of the study region only half the Vatya samples have hydroxyapatite as the primary inlay mineral, with the remainder composed of calcite. This contrasts with the Transdanubian Encrusted Pottery, Szeremle / Dalj-Bjelo Brdo, and Gârla Mare vessels where hydroxyapatite inlays were the norm. There is no indication of any aragonite in the Vatya samples and the addition of crushed quartz was visible in only one sherd, where it formed 10-15% of the composition of the inlay. By comparison, the Gârla Mare material in the south of the study area was extremely homogenous in composition and in the relative proportion of different materials in the inlay mixture: hydroxyapatite was the primary material with the addition of 5-10% quartz. Only one sample contained calcite in the inlay and this was subordinate to hydroxyapatite.

In the two cultural units sitting between the northern and southern poles of the study area – Transdanubian Encrusted Pottery and Szeremle / Dalj-Bijelo Brdo – the majority of inlays are primarily composed of hydroxyapatite with occasional use of calcite. They are, however, differentiated by the consistent presence of quartz in the inlay recipe. Whereas only trace amounts of quartz (less than 5%) are found in some of the Transdanubian Encrusted Pottery samples, in the Szeremle / Dalj-Bijelo Brdo group, 54% of the inlay samples contain more than 5%; some are particularly quartz-rich with 10-15% of the inlay composed of quartz. The quartz grains are angular indicating deliberate crushing and addition to the inlay mixture. Although the Szeremle / Dalj-Bijelo Brdo group in eastern Croatia is traditionally considered as the southern extension of the Transdanubian Encrusted Pottery culture, the addition of quartz and its percentage contribution to the composition of the inlays suggests a greater affinity with practice in making inlays to the south. Overall, the data suggests a north-south divide in terms of the addition of quartz to Middle Bronze Age inlays (**Figure 3**).

The choice of material for Middle Bronze Age inlays appears to be culturally defined and is not primarily related to differences in local availability of materials. Given the location of the Szeremle / Dalj-Bijelo Brdo and Gârla Mare sites along the River Danube, it is likely that the quartz came from readily available quartz float in the river bed. The Vatya site of Százhalombatta is also located on the Danube but here there was very little use of quartz, suggesting that it was not culturally required. There does not seem to be a relationship between the use of calcite and locally available limestone outcrops; the closest limestone deposits to Százhalombatta are approximately 20 km to the north in the Buda Hills. The source of the hydroxyapatite has previously been identified as cremated mammal bone although it is difficult to identify whether the bone is from humans or animals (Roberts / Sofaer / Kiss 2007). It has recently been suggested that some inlays in eastern Croatia may include antler (Kos, et al. 2015).

PREPARATION OF INLAY MATERIALS: TEXTURAL VARIATION

In addition to compositional differences, contrasting textures of inlay suggest variation in the preparation of inlays composed of different starting materials, as well between inlays made of the same combination of materials.

Kostolac inlays are fine-grained and compact even when more than one material was used in the inlay recipe, with a well-mixed and homogenous grain size. This may indicate that the materials were ground together rather than separately (**Figure 4a**). In contrast, Vučedol inlays are consistently granular, angular, and coarsely ground and it is relatively straightforward to distinguish their texture from chronologically earlier and later inlays (**Figure 4b**). In this instance, SEM reveals that aragonitic shell fragments are frequently more coarsely ground and larger than quartz grains. As aragonite is relatively easy to crush (Mohs hardness 3.5 - 4) compared to quartz (Mohs hardness 7) this suggests that the ingredients of the inlay were prepared separately and then brought together. This is supported by the observation that the materials were not always thoroughly mixed, as indicated by occasional clusters of shell or quartz.

All Middle Bronze Age inlays are fine and powdery (**Figure 4c**). However, detailed SEM analysis reveals textual variation within and between cultural units, suggesting a range of different practices in the preparation of inlays (**Figure 5**). The greatest variation is found in the Vatya inlays. Although data presented here comes from a single site (Százhalombatta), there is a wider range of textures at this site than elsewhere. Bone-based inlays alone have at least four different textures. These are distinguishable by the relative length of the largest hydroxyapatite grains and their consistency in size and appearance: fine (blocky grains up to 50 μm in length), medium (blocky grains up to 100 μm in length), fine + medium, and vitrified. Variably sized pieces sitting within a fine matrix (fine + medium) suggest that the animal bone was not always evenly ground. In contrast, Vatya calcite inlays are generally fine and consistent, although there are a few samples with a range of grain sizes.

Variability in Vatya inlays contrasts with notable homogeneity in the visual appearance of Gârla Mare inlays. Under SEM the bone fragments have a blocky appearance and are coarsely ground (up to 150 μm in length), set within a finer matrix containing bone and crushed quartz. As bone is softer than quartz, again this suggests that the different materials were ground separately and then brought together. The materials appear to be evenly mixed, suggesting attention to this aspect of preparation.

Transdanubian Encrusted Pottery and Szeremle / Bijelo-Brdo inlays show a range of textural variation that lies between the heterogeneity of Vatya and the homogeneity of Garla Mare samples. Although each sample looks slightly different under the SEM, the bone-based Szeremle / Bijelo-Brdo inlays have blocky fragments of hydroxyapatite up to 100 μm long set in a fine matrix of bone, or bone and crushed quartz; some of the inlays are composed of a mixture of hydroxyapatite grain sizes, while others tend to have relatively larger grains set within the matrix. The Transdanubian Encrusted Pottery inlays fall into three main categories: randomly orientated angular grains of hydroxyapatite up to 70 μm in length showing a flake-like appearance and set in a finer grained groundmass of hydroxyapatite <1 μm in length; coarse hydroxyapatite grains with a blocky appearance up to 100 μm long with a less well-developed matrix composed primarily of hydroxyapatite; angular fragments of calcite up to 60 μm in length, although the norm is closer to 15 μm, set in a matrix of finer calcite fragments (Roberts / Sofaer / Kiss 2007). The contrasting textures of the bone-based inlays (flakes vs blocks) suggest that although they are of similar chemical composition, there was some variation in manner of preparation of the inlay material. Experimental work in progress aims to explore whether different techniques of crushing and grinding bone result in different textures.

While differences in inlay preparation may to some extent be explained in terms of communities of practice (c.f. Lave and Wenger 1991), the resulting textures observed under the SEM also create visual effects that are perceptible to the naked eye. These may give a clue as to reasons for choices in materials, including the deliberate addition of small amounts of quartz or calcite to the inlay recipe, as well as to the fineness or coarseness of their preparation.

The majority of inlays are white. The calcitic inlays give a strong matt appearance resulting in a 'flat' visual effect. In contrast, the addition of crushed quartz to a shell or bone mixture, even in relatively small proportions, results in a more reflective, glistening, sparkly appearance. Angular, blocky grains (whether of quartz, shell, or bone), as well as varied grain size in an inlay, result in a texture that more efficiently reflects light. Consequently, the coarse textures of some of the Middle Bronze Age bone inlays may have been specifically prepared with this desired optical effect in mind. Likewise, the relatively large grains and angularity of the Classic Vučedol inlays add to their reflectance. Differences in preparation of inlays may therefore have been linked to aesthetic choices and a desire for particular visual effects.

TOOLS AND TECHNIQUES OF THE BODY

Although some cultural units shared forms of tools, there are clear chronological and spatial differences in the choice of implements used to make the beds into which the inlays were applied. Inspection of Kostolac vessels reveals that the impressed decoration has a distinctive shallow but sharp W-shape profile and lines were made with a series of short dashes (c.f. Balen 2011, 89). Vučedol inlay beds were usually made with a pointed T-shape tool, resulting in a deep incision (usually 1.5-2.0 mm) with a wide surface; the width of the incision can be up to 11 mm. This allowed potters to apply thick, coarse inlays that covered large areas of the vessel (**Figure 6a**).

Inlay beds on Middle Bronze Age vessels are generally much shallower than those of the Classic Vučedol (**Figure 6b**). They frequently have a U-shaped profile following the use of tools with rounded ends. However, the range and width of tools varies according to cultural group. The greatest range of tools was employed in the north of the study region in the Vatya culture, echoing the diversity of motifs, materials, and inlay textures found there. The ceramics from Százhalombatta reveal the use of a range of rounded tools and also V-shape tools of different widths, as well as rouletting using a tool akin to a 'pastry-cutter'; several different tools may be used to decorate the same vessel. In the Transdanubian Encrusted Pottery culture the inlay beds are usually shallow (frequently 0.5 mm or less) with only occasional deeper incisions. The width of the incisions is highly variable and is related to motif, but they are most frequently rounded in profile; a triangular tool with a flat end was sometimes used to create a zigzag effect. Rouletting and so-called 'rolled stick' impressions were also used (see Kiss 2012). Szeremle / Bijelo-Brdo inlay beds are similarly shallow but are frequently narrow and made with both rounded and V-shaped tools. The choice and dimensions of tools are most consistent in the Gârla Mare ceramics. Although the motifs on these vessels are extremely complex and elaborate, and each vessel is decoratively distinct in terms of the particular combination of decorative elements, the tools used to make them were very similar and restricted. Our observations suggest that most frequently only a single tool (occasionally two tools) was used to decorate an entire vessel.

The choice and range of tools reflects temporal and spatial differences in techniques of the body and rhythms of practice (de Beaune 2013). For example, Kostolac inlay beds were made by stabbing, impressing, and stamping the tool into the clay in a repeated staccato manner. By contrast, Classic Vučedol vessels were incised using continuous flowing actions to create long smooth lines, appropriate to the use of a pointed 'carving' tool. Sometimes Vučedol inlays were over-painted using ochre to give a red colour on the white. It is apparent that on occasion the pigment spilled over the line of inlay onto the vessel body (**Figure 7**).

The body actions used in most of the Middle Bronze Age groups were a mixture of staccato impressions or dashes where the tool was lifted off the vessel, and continuous flowing actions where it was drawn across the surface. Gârla Mare vessels, however, show a much greater tendency to the use of staccato actions than other contemporary groups; SEM images reveal that lines or motifs that appear continuous to the naked eye, such as the so-called 'garland' were actually made using a repeated series of small gestures in which the tool was removed from the surface of the clay (**Figure 8**). This contrast is analogous to the difference between separated and joined up writing. It reflects learnt embodied practice from which there was very little deviation. In all the cultural units discussed, the margins of the inlay beds are very clean, suggesting that attention was paid to the timing of decoration at the leather hard stage.

METHODS OF APPLICATION

Following incision of the inlay bed the inlay was applied to the vessel. On-going experimental work suggests that organic binding agents such as egg albumin, animal glue, or resins may have been effective ways of holding inlay mixtures together (Anne Kelcey pers comm. 2013) but decomposition of organic materials means that definitive identification of these is difficult. However, an observable range of mechanical methods were also used for ensuring that the inlay remained fixed to the vessel, as well as geochemical indicators relating to the application of inlays.

As most of the Kostolac inlays contain calcite (with a single sample with an inlay made of lime), and as calcite coverts to lime at temperatures above 500^{o}C (McTigue and Wenk 1985), this suggest that the inlays were not present on firing. In addition, the calcite inlays, including the sherd with the lime inlay, do not display any shrinkage gap between the margin of the inlay and the vessel as might be expected following firing. The presence of lime may therefore indicate heat treatment of inlay prior to application to the vessel. All in all, our observations suggest that Kostolac inlays were applied after firing.

Similarly, the identification of aragonite in Classic Vučedol inlays also suggests application after firing. Aragonite converts to calcite at temperatures above 400^{o}C (McTigue and Wenk 1985) and the presence of illite, calcite, and lack of calc silicates or spinels in the pot fabric is consistent with firing temperatures of between 600 and 825^{o}C (Maritan et al. 2006). The lack of aragonite to calcite conversion therefore points to post-firing application for most inlays. Where calcite is the predominant inlay material this may either result from use of naturally occurring calcite or heat treatment of aragonite; it is not, so far, possible to distinguish between these as their chemical signatures are the same.

The widest variety of mechanical methods for ensuring the adherence of the inlay is found in the Vatya samples from Százhalombatta. SEM analysis of sections across the inlay bed shows that in some cases a thin layer of clay was applied to the bed prior to application of the inlay, presumably with the aim of helping it to adhere to the vessel (**Figure 9a**). In another case, hydroxyapatite in the inlay is vitrified with a shrinkage gap between the inlay and the vessel wall (**Figure 9b**). This particular sherd shows no evidence of reburning or vitrification of the vessel itself suggesting that in this example the inlay had been heated at high temperature and inserted prior to firing. Making the inlay bed with a rouletting tool may also be a further means of ensuring the adherence of inlay as it increases the surface area of the bed through the creation of undulations.

Of these methods seen in the Vatya material, so far only the use of rouletting has been observed elsewhere, in some of the Transdanubian Encrusted Pottery sherds (see also Kiss 2012). For the majority of Transdanubian Encrusted Pottery, Szeremle / Bijelo-Brdo and Gârla Mare samples, there is relatively little variation in the methods developed to ensure appropriate adherence of the inlays to the vessel. In section they are tight up against the vessel wall and there is no shrinkage gap or vitrification of the inlay itself (**Figure 9c**). The particles in the inlays are random in orientation suggesting that the inlay was pushed in, rather than stroked or smoothed in some way. There is, however, a single sherd in our data set, from the Szeremle / Bijelo-Brdo group, which may have up to three horizons within the inlay. This could suggest reapplication but it is difficult to know whether this took place as part of the manufacturing process or as repairs.

CONCLUSION

The widespread use of white inlay as a chosen means of decorating ceramics and of highlighting motifs suggests a shared aesthetic between cultural groups in the Carpathian Basin and along the Middle and Lower Danube. There were, however, several different primary materials and combinations of these used to make encrusted ceramics. Inlays were also prepared in different ways, resulting in different textures and light-reflecting qualities. Additional differences can be observed in the tools and techniques of the body used to make the inlay beds, as well as methods of affixing inlay to vessels. These differences reveal contrasting practices and ways of engaging with materials that go beyond what might be expected in terms of variation between the production of individual batches of inlay (**Table 3**). Nor are they related to associations with different kinds of contexts (settlements or cemeteries).

Our data show a clear shift over time away from the use of calcite in the Kostolac, to shell in the Classic Vučedol, and to the widespread use of cremated bone in the Middle Bronze Age. These represent different traditions in the practice of making encrusted ceramics. However, despite these clear temporal trends, practice in the making of inlays reveals a more complex picture than a simple one-to-one association with cultural units. Regional patterns in the combination of materials used for inlay recipes in the Middle Bronze Age show a north-south divide in the use of quartz as a deliberate addition. This is at a level above local stylistic differences, perhaps suggesting a shared desire for inlays with more reflective qualities. Notably, although motifs on Szeremle / Bijelo-Brdo encrusted vessels are usually considered to be typologically influenced by those to the north-west, in composition they are more similar to those further south. However, not all of the Szeremle / Bijelo-Brdo inlays contain quartz and in terms of inlay preparation, tools, and techniques of the body they are less homogeneous than the Gârla Mare samples. This suggests that there are contrasts between cultural units that are a matter of ranges of variation and willingness to innovate, rather than absolute differences. Likewise, there is no one-to-one relationship between cultural unit and the use of calcite inlays in the Middle Bronze Age but there is a tendency for greater use of calcite as a material in the north of the study area, particularly in the Vatya culture.

The most striking differences in the Middle Bronze Age inlays are between the two geographical poles of the study area in terms of the variability notable in Vatya inlays in the north, and the standardization and homogeneity of Gârla Mare inlays in the south. In the former there is a sense of experimentation, creative playing with materials and innovation in practice with potters working within rather loose rules, as seen for example in the different ways to fix inlay to the vessel. By contrast, there is a conservatism in the latter that is evident in all aspects of inlay making which contrasts with the flamboyant use of motifs in the decoration of the vessels. Here the impression is of a 'right way to do things' and of a more technically conservative community that creates itself through these shared routine practices. The Transdanubian Encrusted Pottery culture and Szeremle / Bijelo-Brdo group sit between these two in terms of the degree of variability within our samples, hinting at a north-south gradient in the extent to which potters were able to exercise innovation in the making of inlays.

Our data do not offer easy answers to longstanding debates regarding the relationships between cultural units in the Carpathian Basin and along the Middle and Lower Danube. They do, however, add another layer to these discussions, showing that material choices were complex and sophisticated, with both a degree of independent innovation and, in the Middle Bronze Age, shared practices between some groups at a scale between the region as a whole and local decorative forms. In the particular case of the Vatya inlays, it is apparent that 'freedom' in practice in making encrusted wares contrasts strongly with otherwise highly rule-bound typological aspects of the ceramic assemblage (Budden and Sofaer 2009**,** Sofaer / Bender Jørgensen / Choyke 2013). At Százhalombatta, as with other Vatya sites, inlaid ceramics are much less abundant than in the other cultural groups discussed in this study. It may be that encrusted ceramics were not part of the Vatya 'canon' and could therefore be safely experimented with. Vatya encrusted ceramics are not direct copies of those to the south on any level: the range and use of motifs, materials, preparation, tools, or methods of fixing the inlay to the vessel. Rather, they reveal creativity and innovation in playing with the encrusted ceramics genre, and an awareness and connection to the material culture of others that ran alongside a deep sense of self.

Technical innovation in material culture is bound up with how people engaged creatively in practice and with materials. This means that assumptions regarding the existence of homogenous cultural 'packages', while they may sometimes exist, need not always hold true. Our study of encrusted ceramics shows that making practices that may result in variability can be important to cultural identity, as may those that lead to absolute similarity. In other words, the nature of identity in prehistory is not just about making things the same in order to be the same. It is rather about the balance between similarity and difference through the ways that people directed attitudes to innovation in the practice of making things.

ACKNOWLEDGEMENTS

A version of this paper was first presented in 2014 at the *Balkan Dialogues* Conference at the University of Heidelberg, Germany. We would like to thank the conference organisers and participants for stimulating discussion throughout the event. We would also like to thank the following colleagues and institutions for providing us with samples: Jaqueline Balen, Arheološki Muzej u Zagrebu; Gabriel Crăciunescu, Muzeul Regiunii Porţilor de Fier, Drobeta-Turnu Severin; Domagoj Dujmić, Muzej Slavonije, Osijek; Viktoria Kiss, Magyar Tudományos Akadémia, Budapest; Sanjin Mihelić, Arheološki Muzej u Zagrebu; Nona Palincaș, Institutul de Arheologie 'Vasile Pârvan', Bucharest; Dragana Rajković, Muzej Slavonije, Osijek; Jasna Šimić, Faculty of Humanities and Social Sciences, Sveučilište J.J. Strossmayera, Osijek; Magdolna Vicze, Matrica Múzeum, Százhalombatta. Richard Pearce, University of Southampton assisted with the SEM work. Maps were drawn by Ian Kirkpatrick and annotated by the authors. We are grateful to the anonymous reviewers for their comments. This research was financially supported by HERA grant 09-HERA-JRP-CI-FP-020, *Creativity and Craft Production in Middle and Late Bronze Age Europe*.

REFERENCES

Balen, J. 2005: *Sarvaš – neolitičko i eneolitičko naselje*. (Zagreb, Arheološki muzej u Zagrebu).

Balen, J. 2011: *Đakovo - Franjevac. Late Eneolithic Settlement*. Musei Archaeologici Zagrabiensis Catalogi et Monographiae Vol.7. (Zagreb, Arheološki muzej u Zagrebu).

Bodnár, Cs, Kreiter, A., May, Z., Pánczél, P. and Tóth, M. 2014: Mészbetétes Kerámia az Alföldön – helyi vagy idegen? Encrusted Pottery in Eastern Contexts; 'foreign' or local? A bronzkor kutatásának helyzete Magyarországon. MTA BTK RI és ELTE BTK RI, Budapest December 17-18 2014.

Bóna, I. 1975: *Die Mittlere Bronzezeit Ungarns und ihre südöstlichen Beziehungen*. (Budapest, Akadémia Kiadó).

Budden, S. and Sofaer, J. 2009: Non-Discursive Knowledge and the Construction of Identity. Potters, Potting and Performance at the Bronze Age Tell of Százhalombatta, Hungary. *Cambridge Archaeological Journal*, 19(2), 203-220.

Črešnar, M. 2010; Poskus Določitve Kulturne Skupine Kisapostag V Vzhodni Sloveniji (Attempted Definition Of The Kisapostag Culture Of The Early Bronze Age In North-Eastern Slovenia). *Zbornik soboškega muzeja* 15, 107-134.

de Beaune, S. 2013: Introduction: Esthétique du geste technique, *Gradhiva* 1/2013 (n° 17), pp. 4-25

Dimitrijević, S. 1977-78: Zur Frage der Genese und der Gliederung der Vučedoler Kultur in dem Zwischenstromlande Donau-Drau-Sawe. *Vjesnik Arheološkog muzeja u Zagrebu,* 3. s., X-XI, 1-96.

Dimitrijević, S. 1979: Vučedolska kultura i vučedolski kulturni kompleks. *Praistorija jugoslavenskih zemalja III*. (Sarajevo), 267-341.

Durman, A. 1988: The Vučedol Culture. In Durman, A. (ed.), *Vučedol. Three Thousand Years B.C.* Exhibition Catalogue (Zagreb, Muzejsko-galerijski Centar and Department of Archaeology of the Faculty of Humanities and Social Sciences in Zagreb), pp. 45-48.

Kiss, V. 2012: *Middle Bronze Age Encrusted Pottery in Western Hungary. Varia Archaeologica Hungarica XXVII* (Budapest: Archaeolingua).

Kiss, V. 2013: Problems of the Koszider Period in Transdanubia. In Vicze, M., Poroszlai, I. and Sümegi, P. (eds) *Koszider: Hoard, Phase, Period? Round table conference on the Koszider problem* (Matrica Museum: Százhalombatta), 63-96.

Kos, K., Posilivić, H. and Durman, A., Ristić, M. and Krehula, S. 2015: White Encrustation Produced from Deer Antler Phosphate on Prehistoric Ceramics from Podunavlje. *Archaeometry* 57(4), 636-652.

Kos, K., Posilivić, H. and Durman, A. 2013: Prapovijesne inkrustacije u Podunavlju. Obavijesti - Hrvatsko arheološko društvo XLV, 17-24.

Lave, J. and Wenger, E. 1991: *Situated Learning: Legitimate Peripheral Participation* (Cambridge, Cambridge University Press).

Maritan, L., Nodari, L., Mazzoli, C., Milano, A., Russo, U. 2006: Influence of firing conditions on ceramic products: Experimental study on clay rich in organic matter. *Applied Clay Science* 31(1-2), 1-15.

Mauss, M. 1935 [2006]: Les techniques du corps. In Schlanger, N. (ed.) *Marcel Mauss: Techniques, Technology and Civilisation* (Oxford: Durkheim Press), 77–95. [Trans. B. Brewster]

McTigue, J.W. and Wenk, H.R. 1985: Microstructure and orientation relationships in the dry-state aragonite-calcite and calcite-lime phase transitions. *American. Mineralalogist* 70, 1253-1261.

Motzoi-Chicideanu, I. 2011: *Obiceiuri funerare în Epoca Bronzului la Dunărea Mijlocie și Inferioară* (Bucharest: Editura Academiei Române).

Reich, C. 2006: *Das Gräberfeld von Szeremle und die Gruppen mit inkrustierter Keramik entlang mittlerer und unterer Donau* (Berlin: Staatliche Museen zu Berlin).

Roberts, S., Sofaer, J. and Kiss, V. 2007: Characterisation and textural analysis of Middle Bronze Age Transdanubian inlaid wares of the Encrusted Pottery Culture, Hungary. A preliminary study. *Journal of Archaeological Science* 35(2), 322-330.

Şandor-Chicideanu, M. 2003: *Cultura Žuto Brdo-Gârla Mare. Contribuții la cunoaşterea epocii bronzului la Dunărea Mijlocie și Inferioară* (Cluj-Napoca, Editura Nereamia Napocae).

Šimić, J. 2000: *Kulturne skupine s inkrustiranom keramikom u brončanom dobu sjeveroistočne Hrvatske* (Cultural groups with encrusted ceramics in the Bronze Age in north-east Croatia (Osijek, Muzej Slavonije Osijek).

Sofaer, J. 2015: Clay in the Age of Bronze. *Essays in the Archaeology of*

Prehistoric Creativity (Cambridge, Cambridge University Press).

Sofaer, J., Bender Jørgensen, L., Choyke, A. 2013: Craft Production: Ceramics, Textiles and Bone. In Harding, A. and Fokkens, H. (eds) *Oxford Handbook of the European Bronze Age* (Oxford, Oxford University Press), 469-491.

Sofaer, J., Mihelić, S., Roberts, S. and Williams, R. 2013: The Composition of Inlays in Encrusted Ceramics from the Pannonian Plain. *Croatian Archaeological Society Annual Meeting*, Vukovar, Croatia.

Sørensen, M.L.S. 2015: 'Paradigm Lost' – On the State of Typology Within Archaeological Theory. In Kristiansen K., Šmedja, L. and Turek, J. (eds) *Paradigm Found. Archaeological Theory Past, Present and Future. Essays in Honour of Evžen Neustupný* (Oxford, Oxbow Books), 84-94.

Tasić, N. 2003-2004: Historical Picture of Development of Bronze Age Cultures in Vojvodina. *Starinar* LIII-LIV, 23-34.

Vicze, M. and Poroszlai, I. (eds.) 2000: *Százhalombatta Archaeological Expedition (SAX) Annual Report I (*Matrical Museum, Százhalombatta).

SUMMARY

This paper explores the relationship between technical innovation and social identity in the practice of making of encrusted ceramics. The widespread use of white inlay as a means of decorating ceramics and of highlighting motifs suggests a shared aesthetic between cultural groups in the Carpathian Basin and along the Middle and Lower Danube. There were, however, several different primary materials and combinations of these used to make inlays including animal bone, crushed shell (aragonite), calcite, and quartz; there is a clear shift over time away from the use of calcite and shell to bone. Inlays were also prepared in different ways, resulting in different textures and light-reflecting qualities. In addition, there is variation in the tools and techniques of the body used to make the inlay beds, as well as methods of affixing inlay to vessels. These differences reveal contrasting practices and ways of engaging with materials that go beyond what might be expected in terms of variation between the production of individual batches of inlay. Nor are they related to associations with different kinds of contexts, for example settlements or cemeteries.

Keywords: Encrusted Ceramics, Eneolithic and Bronze Age, Carpathian Basin, Middle and Lower Danube, Innovation, Social Identity, Practice