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ABBREVIATIONS

AAR	Analecta Archaeologica Ressoviensia (Rzeszów)
ActaArch	Acta Archaeologica (Leiden)
ActaArchHung	Acta Archaeologica Academiae Scientiarum Hungaricae (Budapest)
ActaMusPapensis	Acta Musei Papensis. A Pápai Múzeum Értesítője (Pápa)
Agria	Agria. Az Egri Múzeum Évkönyve (Eger)
AJPA	American Journal of Physical Anthropology (New York)
Alba Regia	Alba Regia. Annales Musei Stephani Regis (Székesfehérvár)
AnB	Analele Banatului. Buletinul Muzeului din Timişoara (Timişoara)
Antaeus	Antaeus. Communicationes ex Instituto Archaeologico (Budapest)
AnthrAnz	Anthropologischer Anzeiger (München)
AnthrK	Anthropológiai Közlemények (Budapest)
Antiquity	Antiquity. A Review of World Archaeology (Durham)
AÖ	Archäologie Österreichs (Wien)
Apulum	Apulum. Acta Musei Apulensis (Alba Iulia)
AR	Archeologické Rozhledy (Praha)
ArchA	Archaeologia Austriaca (Wien)
ArchBulg	Archaeologia Bulgarica (Sofia)
ArcheoSciences	ArcheoSciences. Revue d'Archéométrie (Rennes)
ArchÉrt	Archaeologiai Értesítő (Budapest)
ArchHung	Archaeologia Hungarica (Budapest)
Archiv für Anthropologie	Archiv für Anthropologie. Völkerforschung und kolonialen Kulturwandel (Braunschweig)
ArchKözl	Archaeologiai Közlemények (Budapest)
Arrabona	Arrabona. A Győri Xantus János Múzeum Évkönyve (Győr)
ASM	Archeologické Studijní Materiály (Praha)
AUB	Annales Universitatis Budapestinensis de Rolando Eötvös Nominatae (Budapest)
AVANS	Archeologické Výskumy a Nálezy na Slovensku (Nitra)
Balcanica	Balcanica. Annuaire du Comité Interacadémique de Balkanologie du Conseil des Académies des Sciences et des Arts de la R. S. F. Y. et de l'Institut des Etudes Balkaniques (Beograd)
BAR-IS	British Archaeological Reports – International Series (Supplementary) (Oxford)
BBV	Berliner Beiträge zur Vor- und Frühgeschichte (Berlin)
bioRxiv	bioRxiv. The Preprint Server for Biology
BRGK	Bericht der Römisch–Germanischen Kommission (Berlin)
BROB	Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek (Amersfoort)
BudRég	Budapest Régiségei (Budapest)
CommArchHung	Communicationes Archaeologicae Hungariae (Budapest)
Crisia	Crisia (Oradea)
CurrAnt	Current Anthropology (Chicago)

DissArch	Dissertationes Archaeologicae ex Instituto Archaeologico Universitatis de Rolando Eötvös nominatae (Budapest)
DMÉ	A Debreceni Déri Múzeum Évkönyve (Debrecen)
DocPraehist	Documenta Praehistorica (Ljubljana)
Dolg	Dolgozatok az Erdélyi Múzeum Érem- és Régiségtárából (Kolozsvár)
Dolgozatok	Dolgozatok a Magyar Királyi Ferencz József Tudományegyetem Archaeologiai Intézetéből (Szeged)
DuDolg	Dunántúli Dolgozatok (Pécs)
DuSz	Dunántúli Szemle (Szombathely)
EJA	European Journal of Archaeology (London)
Építés-Építészettudomány	Építés- Építészettudomány. A Magyar Tudományos Akadémia Műszaki Tudományok Osztályának Közleményei (Budapest)
EurAnt	Eurasia Antiqua. Zeitschrift für Archäologie Eurasiens (Bonn)
FAM	Fontes Archaeologiae Moravicae (Brno)
FolArch	Folia Archaeologica (Budapest)
FontArchHung	Fontes Archaeologici Hungariae (Budapest)
FrK	Földrajzi Közlemények (Budapest)
FSI	Forensic Science International. Genetics
FtK	Földtani Közlöny (Budapest)
GCBI	Godišnjak Centra za Balkanološka Ispitivanja Akademije Nauka i Umjetnosti Bosne i Hercegovine (Sarajevo)
Germania	Germania. Anzeiger der Röm.-Germ. Kommission des Deutschen Archäologischen Instituts (Mainz)
Gesta	Gesta. Historical Review (Miskolc)
HHR	The Hungarian Historical Review (Budapest)
HOMÉ	A Herman Ottó Múzeum Évkönyve (Miskolc)
HungArch	Hungarian Archaeology. E-Journal (Budapest)
JAA	Journal of Anthropological Archaeology (New York)
JAHA	Journal of Ancient History and Archaeology (Cluj-Napoca)
JAR	Journal of Archaeological Research (New York)
JAS	Journal of Archaeological Science (London)
JFA	Journal of Field Archaeology (Boston)
JFS	Journal of Forensic Sciences (Chicago)
JHE	Journal of Human Evolution (New York)
JIES	The Journal of Indo-European Studies (Washington, D. C.)
JLS	Journal of Lithic Studies (Edinburgh)
JPMÉ	A Janus Pannonius Múzeum Évkönyve (Pécs)
JWP	Journal of World Prehistory
KMK	A Komárom megyei Múzeumok Közleményei (Tata)
KMMK	Komárom-Esztergom Megyei Múzeumok Közleményei (Tata)
KRMK	A Kaposvári Rippl-Rónai Múzeum Közleményei (Kaposvár)
Marisia	Marisia. Studii şi Materiale. Muzeul Judeţean Tîrgu Mureş (Tîrgu Mureş)
MatArchSlov	Materialia Archaeologica Slovaca (Nitra)
MCA	Materiale şi Cercetări Archeologice (Bucureşti)
Menga	Menga. Revista de prehistoria de Andalucía. Journal of Andalusian Prehistory (Antequera)
MFMÉ	A Móra Ferenc Múzeum Évkönyve (Szeged)
MFMÉ StudArch	A Móra Ferenc Múzeum Évkönyve – Studia Archaeologica (Szeged)

MKCsM	Múzeumi Kutatások Csongrád Megyében (Szeged)
MRT	Magyarország Régészeti Topográfiája (Budapest)
Musaica	Musaica Archaeologica. Zborník Filozofickej Fakulty University Komenského (Bratislava)
Nartamongæ	Nartamongae. The Journal of Alano-Ossetic Studies. Epic, Mythology and Language (Vladikavkaz)
OA	Opuscula Archaeologica (Zagreb)
Ossa	Ossa. International Journal of Skeletal Research (Solna)
Ősrégészeti Levelek	Ősrégészeti Levelek. Prehistoric Newsletter (Budapest)
PBF	Prähistorische Bronzefunde (München)
PLoS One	PLoS One. E-Journal (San Francisco)
PNAS	Proceedings of the National Academy of Sciences (Washington, D. C.)
Pravěk	Pravěk (Brno)
Preistoria Alpina	Preistoria Alpina (Trento)
PZ	Praehistorische Zeitschrift (Berlin)
QuaternaryInt	Quaternary International. The Journal of the International Union for Quaternary Research (Oxford – New York)
Radiocarbon	Radiocarbon. An International Journal of Cosmogenic Isotope Research (Tucson)
RégFüz	Régészeti Füzetek (Budapest)
SA	Советская Археология (Moskva)
Satu Mare	Satu Mare. Studii şi comunicări. Seria Arheologie (Satu Mare)
Savaria	Savaria (Szombathely)
SbČSA	Sborník Československé Společnosti Archeologické (Brno)
SCIV	Studii şi Cercetări de Istorie Veche (Bucureşti)
SlA	Slovenská Archeológia (Bratislava)
SMK	Somogyi Múzeumok Közleményei (Kaposvár)
Specimina Nova	Specimina Nova. Dissertationum ex Instituto Historiae Antiquae et Archaeologiae Universitatis Quinqueecclesiensis (Pécs)
SSz	Soproni Szemle (Sopron)
StComit	Studia Comitatensia (Budapest)
SzIKMK	A Szent István Király Múzeum Közleményei (Székesfehérvár)
Terra Sebus	Terra Sebus. Acta Musei Sabesiensis (Sebes)
Tisicum	Tisicum. A Jász-Nagykun-Szolnok Megyei Múzeumok Évkönyve (Szolnok)
UF	Ugarit-Forschungen. Internationales Jahrbuch für die Altertumskunde Syrien-Palästinas (Kevelaer – Neukirchen– Vluyn)
UPA	Universitätsforschungen zur prähistorischen Archäologie (Bonn)
VAH	Varia Archaeologica Hungarica (Budapest)
VetZoot	Veterinarija ir Zootechnika. A scientific journal and the Official Organ of the Veterinary Academy, Lithuanian University of Health Sciences (Kaunas)
VKT	Várak, kastélyok, templomok. Történelmi és örökségturisztikai folyóirat (Pécs)
VMMK	A Veszprém Megyei Múzeumok Közleményei (Veszprém)
VýP	Východoslovenský Pravek (Košice)
WMMÉ	A Wosinsky Mór Múzeum Évkönyve (Szekszárd)
ZalaiMúz	Zalai Múzeum (Zalaegerszeg)
ZbSNM	Zborník Slovenského Národného Múzea. Archeológia (Bratislava)
Ziridava	Ziridava. Studia Archaeologica (Arad)
ZSNM	Zbornik Slovenského Národného Múzea (Ljubljana)

FOREWORD FROM THE EXECUTIVE EDITOR

As with the previous (37th) issue of the Antaeus (Yearbook of the Institute of Archaeology), the present volume brings together a selection of research papers addressing a certain time period; the Bronze Age on this occasion. The current volume, despite containing fewer studies than the previous issues, is in line with the editorial board's ambition to publish a new volume at regular – annual – intervals, even at the expense of the overall length of the publication. With the aim to assemble a broad spectrum of Bronze Age research studies from the territory of Hungary, the current issue touches upon a wide range of themes stretching across the many hundreds of years of the Bronze Age period: from the facial reconstruction of an Early Bronze Age woman, to the domestication of horses and Middle Bronze Age dress ornaments, to the study of the large, Late Bronze Age fortified settlements. These topics cover the key issues of current European Bronze Age research, including the archaeological application of DNA analyses, and the theoretical approaches of political economies, therefore the outcomes presented here will hopefully be of wide international interest. Some of the research was carried out within the framework of the Lendület/Momentum Mobility Research Group launched in 2015, supported by the Hungarian Academy of Sciences at the Institute of Archaeology, Research Centre for the Humanities.

The paper by Ágnes Kustár and her colleagues presents the facial reconstruction of an Early Bronze Age female burial. The work serves as the first facial reconstruction study where DNA data was also considered regarding the pigmentation (eye and hair colour, skin tone) of a Bronze Age individual from present-day Hungary.

The two studies put forward by Eszter Melis and Gabriella Kulcsár as main authors, both discuss the results of micro-regional settlement investigations aimed to explore Early and Middle Bronze Age settlement structures using non-destructive methods. The settlement investigations conducted by Eszter Melis and her team focussed on the region of Nagycenk, nearby Lake Neusiedl. The data published here represents a significant piece of archaeological research as information from the region occupied by the Gáta–Wieselburg culture has been lacking in the past three decades. Furthermore, the site of Nagycenk-Kövesmező is one of the few Gáta–Wieselburg settlements investigated by a modern archaeological excavation.

Gabriella Kulcsár and her team discuss the Middle Bronze Age pit burial of a mature adult female with evidence for multiple physical trauma, from Central Hungary. The study touches upon the interpretation of pit burials in the context of the settlements of Bronze Age communities who otherwise practiced inhumation and cremation as their nominal mortuary tradition.

Géza Szabó's paper examines the so-called Tolnanémedi-type hoard horizon comprised primarily of dress ornament assemblages across to the Middle Bronze Age along with a newly discovered hoard from Mucsi in Tolna county. The publication includes the reconstruction of a costume worn by high status female members of the Transdanubian Encrusted Pottery culture and provides an interpretation of the symbolism of such ornaments.

The study by Gábor Ilon provides an overview of Bronze Age moulds and their distribution in the Carpathian Basin. The paper considers the assemblage as important evidence for local metallurgy, and sheds new light on the organisation and specialisation of bronze production.

Róbert Bozi and Géza Szabó explore the question of horse domestication within the context of Bronze Age cultures in Central and Eastern Hungary, based on the evidence of horse gear made of antler appearing first during the 2nd millennium in the Carpathian Basin. The study relies on newly discovered horse remains and their associated absolute dates.

The paper by Vajk Szeverényi and his colleagues discusses the results of their most recent excavation programme conducted at Csanádpalota; a prime example of a so-called 'mega fort' or large-scale fortified settlement typical in the Late Bronze Age in Southeast Europe. Anna Priskin in her study gives a detailed insight into the production and use of grinding stones recovered at the site.

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ÁGNES KUSTÁR – DÁNIEL GERBER – SZILVIA FÁBIÁN – KITTI KÖHLER – BALÁZS GUSZTÁV MENDE – ANNA SZÉCSÉNYI-NAGY – VIKTÓRIA KISS

FACIAL RECONSTRUCTION OF AN EARLY BRONZE AGE WOMAN FROM BALATONKERESZTÚR (WESTERN HUNGARY)

Zusammenfassung: Während der Ausgrabungen, die dem Bau der Autobahn M7 vorangingen, kamen am Fundort Balatonkeresztúr-Réti-dűlő, zwischen 2003 und 2004 Funde neun verschiedener archäologischer Epochen zum Vorschein, darunter auch eine auf das Ende der Frühbronzezeit datierbare Siedlung der Kisapostag-Kultur und 12, hauptsächlich beigabenlose Bestattungen. In Grab 13 ruhte eine ungefähr 35-45 Jahre alte Frau, um deren Schädel herum kleine Metallverzierungen aufgedeckt wurden, die zu einem Kopf- oder Kappenschmuck gehörten und darauf hinwiesen, dass die Verstorbene innerhalb der Siedlungsgemeinschaft einen höheren gesellschaftlichen Rang innehatte. Der Schädel im Grab war in sehr gutem Zustand, somit ergab sich die Möglichkeit, die einstigen Gesichtszüge der Frau zu rekonstruieren, gleichzeitig war dies die erste weibliche Gesichtsrekonstruktion der ungarischen Bronzezeit. Im Rahmen unserer Studie beschreiben wir den Vorgang der plastischen Gesichtsrekonstruktion, wofür wir auch die anhand genetischer Untersuchungen gewonnenen phänotypischen Angaben (Augen- und Haarfarbe, Teint) verwendet haben.

Keywords: inhumation burial, bioarchaeology, archaeogenetics, anatomy, sculpting craniofacial reconstruction, Kisapostag/Earliest Encrusted Pottery culture, Early Bronze Age, Western Hungary

At site Balatonkeresztúr-Réti-dűlő (Somogy county), on the south shore of Lake Balaton, 2976 archaeological features were discovered over an area of 45.000 m^2 during the 2003–2004 excavations (supervised by Szilvia Fábián) preceding the construction of the M7 Motorway. These features belonged to nine archaeological periods: Middle and Late Copper Age (Balaton–Lasinja, Furchenstich, Boleráz and Baden cultures), Early Bronze Age (Somogyvár–Vinkovci and Kisapostag/Earliest Encrusted Pottery cultures), Middle Bronze Age (Transdanubian Encrusted Pottery culture), Late Iron Age (La Tène D period), Migration period (Longobards), the Árpádian period (12th–13th centuries), and the Late Middle Ages (13th–15th centuries).[1] Beside settlement features associated with the Early and Middle Bronze Ages, an inhumation cemetery presumably used in the same period was also discovered. The twelve burials of the cemetery were arranged in two groups: one with six graves (Group A: Graves 1, 2, 3, 5, 6, and 7) and the other comprising four graves (Group B: Graves 4, 8, 11, and 13), and there were two more graves (Graves 10 and 45) somewhat further away. The burials were oriented N–S or NE–NW, and the deceased were laid in the burial pits in a so-called contracted position, with their legs slightly or tightly flexed, and, in most cases, with their hands placed in front of their faces. Most of the burials were without grave goods; only two burials contained jewellery, which formed part of the wear of the deceased. One of the latter is Grave 13 belonging to Group B *(fig. 1),* in which the fragments of copper or bronze beads were discovered around the skull of an adult woman. Based on these finds – and similar

[1] *Honti et al. 2004; Honti et al. 2006* 26–29; *Fábián – Serlegi 2009.*

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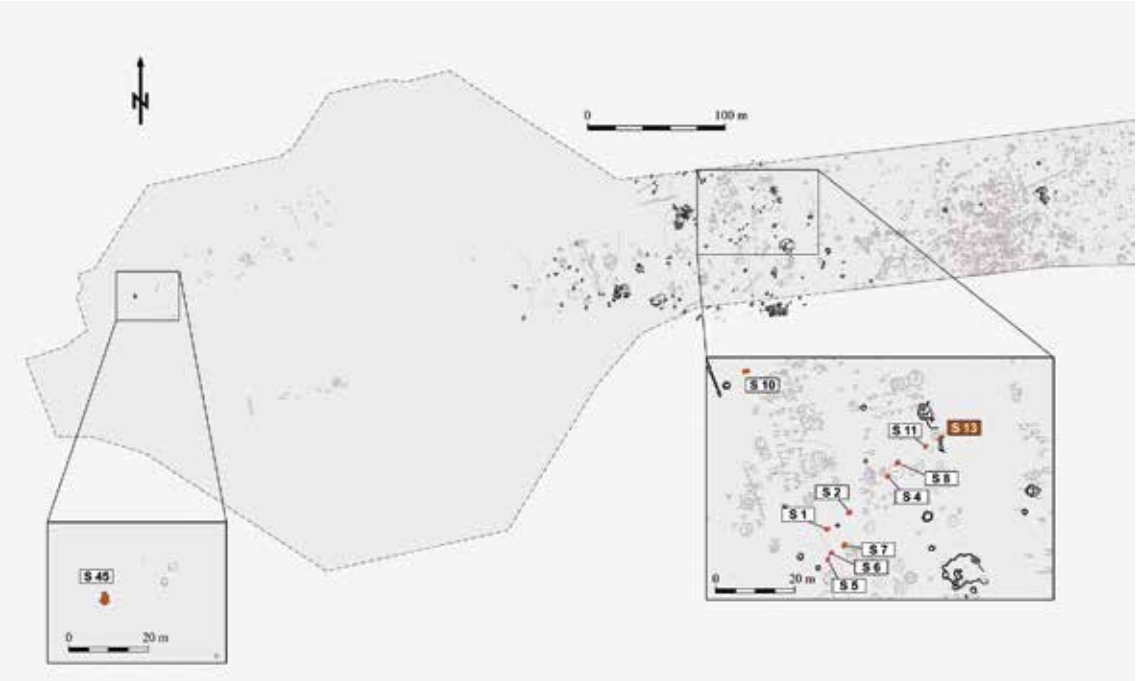

Fig. 1. The site Balatonkeresztúr-Réti-dűlő, with the position of Early Bronze Age burials; Grave 13 signed in colour (©Zsolt Viemann, ©Zsolt Réti)

burials – we assumed that the graves belonged to the Early Bronze Age.[2] Closer data were later offered by the radiocarbon analysis of samples taken from the bones of the deceased. According to these, the burials were made sometime between 2150 and 1870 BC, so they can be associated with the population of the Kisapostag/Earliest Encrusted Pottery culture.[3]

Balatonkeresztúr-Réti-dűlő Grave 13, the burial of a middle-aged woman

Archaeological and anthropological data

The woman in Grave 13, laid on her left side with her legs pulled up, was buried in a slightly different pose from the rest of the deceased as she covered her face with her right arm *(fig. 2).* During the anthropological examination of the remains comprising a relatively well-preserved skull and skeletal bones of the 35-45-year-old woman (see anthropological analysis below in details), no signs of external trauma or disease on the skeleton were detected, so the cause of death is currently unknown. According to radiocarbon tests carried out at the laboratory of the Isotope Climatology and Environmental Research Centre (ICER), Institute for Nuclear Research (ATOMKI) in Debrecen, the woman was most probably buried between 2040 and 1890 BC (DeA 21 200; 3618 ± 30 BP; 68.2%: 2023–1942 BC, 95.4%: 2120–1891; 90.9%: 2039–1891) *(fig. 3).*[4]

Fragments of copper or bronze plate beads unearthed from the grave suggest that the woman had a relatively high social status within the community living at the settlement. These tubular beads made of metal belonged to the typical headdress or cap of the era. Similar beads were

[2] *Honti et al. 2004* 13, Table III. 2; *Kiss 2020a; Gerber et al. preprint,* Supplementary.

[3] On the data of radiocarbon dating in detail: *Gerber et al. preprint.*

[4] The dates were calibrated with the 'OxCal' v4.4 software *(Bronk Ramsey 2009)* using the IntCal20 Northern Hemisphere radiocarbon calibration curve *(Reimer et al. 2020).*

Fig. 2. Balatonkeresztúr-Réti-dűlő, Grave 13 (©Szilvia Fábián, ©Zsolt Réti, ©Fanni Gerber)

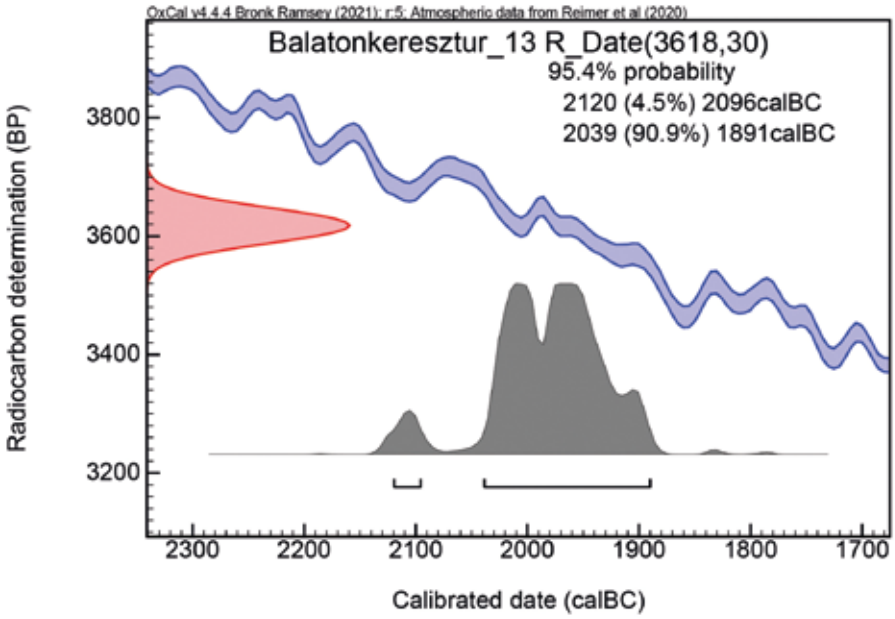

Fig. 3. Balatonkeresztúr-Réti-dűlő, calibrated AMS dating of Grave 13 (©Viktória Kiss)

found, among other things, in Grave 400 unearthed at site Ordacsehi-Csereföld nearby, the burial of a woman who died around the age of 48-57 years, and a reconstruction drawing was made of a possible way the beads were worn.[5] The analysis of the metal tubes showed that they were made of copper (instead of tin bronze), with some arsenic, silver, and antimony components (93–95% copper, 1–2% arsenic, 1.5–2% silver, 3–3.5% antimony, 0.3% lead).[6] Tubes twisted from sheet metal or wires were also worn as a necklace or sewn onto a garment, as can be seen in Grave 242 of the cemetery excavated at Bonyhád-Biogas Factory, the burial of a 30-35-year-old woman. Although the metal bead fragments discovered at Balatonkeresztúr have not been subjected to compositional analyses so far, the analyses of the beads from Ordacsehi and Bonyhád show that the pieces dating to the Early Bronze Age and the beginning of the Middle Bronze Age were made of copper,[7] even though tin bronze tools and weapons emerged in the region around 2000/1900 BC.[8] Unalloyed copper with low arsenic, antimony, and silver contents, which could be shaped easily, was a more suitable raw material for the production of these beads.[9] This material most probably have come from the territory of the Slovak Ore Mountains.[10]

We determined the age of the individual at the time of death on the basis of the wear of the teeth, the ossification of the cranial sutures, and the ribbed surface of the *facies symphyseos*.[11] The sexualisation value (-0.81) has a feminine character.[12] We recorded the metrics of skulls and long bones,[13] based on which we defined the most important indices and carried out categorisation.[14]

5 *Somogyi 2004; Somogyi 2007.*
6 *Költő 2004.*
7 *Szabó 2010; Kovács et al. 2019.*
8 *Kiss 2020b.*
9 *Kovács et al. 2019.* In the second half of the Middle Bronze Age, however, similar ornaments for clothing were already made of tin bronze, see *Kiss – Barkóczy – Vízer 2013; Maróti – Káli 2021.*
10 *Duberow – Pernicka – Krenn-Leeb 2009; Kiss 2020b.*
11 *Nemeskéri – Harsányi –Acsádi 1960; Sjøvold 1975; Miles 1963; Perizonius – Pot 1981.*
12 *Éry – Kralovánszky – Nemeskéri 1963.*
13 *Martin – Saller 1957.*
14 *Alekseev – Debec 1964.*

Additionally, we calculated the height of the individual based on the size of the long bones.[15] The stature (158.7 cm) is large-medium.[16] In absolute terms, the values of the skull are medium-long, wide, and high (*brachy-*, *chamae-*, and *tapeinocran*). The frontoparietal index is narrow *(stenometop)*. In a vertical view, the brain case is pentagonoide-shaped, while viewed from the *occipitale*, it is house-shaped. The nape has a curvoccipital profile. The *glabella* is grade 2 and the *protuberantia occipitalis externa* is grade 2.[17] In absolute terms, the face is medium-high, and the upper face is high. The orbital cavities are *mesokonch*. The nose is *mesorrhin*. Of the anatomical variations,[18] suture bones can be observed on both sides of the lambda suture. Of the 29 preserved teeth, cervical caries can be seen in the lower left 2nd molar. The lower left 3rd molar fell out during the individual's life. The degree of abrasion is grade 4–5.[19]

The skull in the grave has been preserved in a very good condition, which allowed us to carry out the reconstruction of the woman's facial features. This was, at the same time, the first female facial reconstruction from the Bronze Age in Hungary.[20]

Archaeogenetic methods and results

The archaeogenetic studies were carried out at the Institute of Archaeogenomics, Research Centre for the Humanities (Eötvös Loránd Research Network) with up-to-date methodology. Samples were taken from Early Bronze Age human remains found at the site, in accordance with the international standards: from the *pars petrosa* bone or, in the absence of it, from the tooth. In the case of the woman from Grave 13, belonging to the Kisapostag/Earliest Encrusted Pottery culture, the samples were taken from the petrous bone. DNA library creation and preparation for shotgun sequencing were carried out in dedicated sterile laboratory facilities following the most recent methodology.[21] An average of 5 million randomly selected DNA fragments were subjected to shotgun sequencing per sample, using the sequencing platforms Illumina MiSeq and NovaSeq. Bioinformatical analyses consisted of raw sequencing read filtering and mapping to the human reference genome (hg19 version) and post-filtering. We used the 1.240 million panels to call SNPs (Single Nucleotide Polymorphism, frequently used genomic markers in ancient DNA analyses), from which an average of 101 thousand SNPs were retrieved from the population of this study. This was sufficient amount for various population genetic analyses, including PCA and allele-frequency-based methods, and also even for a – limited – phenotypic variant discovery. For the latter, we were mainly interested in clinical and pigmentation variants, for which we used existing panels (e.g. Hirisplex) arbitrarily extended with database data.[22] The variant calling of the woman found in Grave 13 yielded a total of 104 929 SNPs from the 1.240 million panels. The composition of her nuclear genome fits in the Kisapostag/Earliest Encrusted Pottery culture-associated genomes available so far.[23] This group comprised the genetic material[24] of all the three major European genetic components: the Mesolithic hunter-gatherer indigenous population who lived here before the advent of agriculture, the Anatolian farming people who arrived in the Carpathian Basin in the Neolithic Age, in the 6th millennium BC, as well as the shepherds who

[15] *Sjøvold 1990.*
[16] *Martin – Saller 1957; Alekseev – Debec 1964.*
[17] See note 13.
[18] *Hauser – De Stefano 1989.*
[19] See note 11.
[20] For the Bronze Age facial reconstruction based on a male burial excavated in Tiszafüred, which is the first reconstruction from the Bronze Age in Hungary, see *Kustár et al. 2020.*
[21] *Dabney et al. 2013; Rohland et al. 2015; Lipson et al. 2017.*
[22] *Walsh et al. 2014; Walsh et al. 2017; Chaitanya et al. 2018.*
[23] *Gerber et al. preprint.*
[24] *Haak et al. 2015; Fu et al. 2016; Lipson et al. 2017.*

moved here from the east at the dawn of the Bronze Age, in the first third of the 3rd millennium BC. Interestingly, an increased hunter-gatherer ancestry, previously unknown from this era clearly separates the Kisapostag/Earliest Encrusted Pottery culture associated individuals from other known Bronze Age populations of Europe.[25] After their arrival to the Transdanubia, their specific genetic makeup thinned out generation by generation, but remained characteristic for centuries in the region. The exact origin of their peculiar genetic makeup is yet to be described. Based on the paternal (Y-chromosome) relations discovered in the Balatonkeresztúr cemetery, the communities of the culture may belong to a fundamentally patriarchal society. Female exogamy – a general phenomenon in the Bronze Age – can also be observed among them based on admixture proportions, although this may have been limited, as the woman buried in Grave 13 was born and lived in the vicinity of the site according to local Sr isotope signature and had the specific genetic features of the Kisapostag/Earliest Encrusted Pottery population. Data from other sites[26] also support that communities belonging to the culture may have been based on families along the male line or a clan-type society. The 35-45-year-old woman had a pre-eminent position in this society according to the metal grave goods. Since she was found together with closely related individuals, we can hypothesise that she was part of those familiar groups despite not having any blood relationship with them up to a second degree. Her phenotypic traits can be estimated through the variants of her MC1R, OCA2, HERC2, SLC24A4, TYR, IRF4, TYRP1, PIGU, and RALY genes. Considering the results, despite her minor steppe heritage, she blended into the Neolithic pigmentation patterns.[27] Fundamentally, she had rather creole-toned skin and brownish blond hair of a darker shade. Her face may have been freckled and her eye colour was shaped by both the genetic variants responsible for blue and brown pigmentation.

In the absence of written records from the Bronze Age, the names of the middle-aged woman and her contemporaries are not known. We named this woman Jelena after the date when her grave was discovered (name day Jelena/Ilona on 18 August)[28] and the results of the genetic tests, as she belonged to J2b1 mitochondrial haplogroup or maternal lineage.

Facial reconstruction

Facial reconstruction can be used to represent the facial features of people who lived in the past. Currently, it is predominantly used by the police in forensic identification to reveal the identities of unknown corpses. In medicine, facial surgeons (maxillofacial surgeons) and plastic surgeons also use the technique of facial reconstruction to plan surgeries for replacing both bones and soft tissues.

The skull of the woman buried in Grave 13 at Balatonkeresztúr is in good condition. The right zygomatic bone is damaged, and the right temporal squama is incomplete *(fig. 4).* According to the anthropological examination of the skeleton, Jelena's stature was large-medium (approximately 159 cm) with a gracile skeleton. The age of about 35-45 years is slightly higher than the average age of the local Bronze Age population.

The facial reconstruction was started by making the exact copy of the original skull. To maintain the intactness of the skull, we used rapid prototyping technology that is sufficiently accurate and does not damage the bones. The computed tomography (CT) scan of the skull was

[25] *Olalde et al. 2018.*

[26] *Gerber et al. preprint.* See also the examination of individuals, from a slightly younger period contemporaneous with the mass grave discovered at Balatonkeresztúr, from site Jagodnjak (Croatia): *Freilich et al. 2021.*

[27] In detail see *Gerber et al. preprint.*

[28] See name days in Hungary: https://hu.wikipedia.org/wiki/Magyar_n%C3%A9vnapok_list%C3%A1ja_bet%C5%B1rendben [last accessed 20.02.2022].

Fig. 4. The skull of the Bronze Age woman from Balatonkeresztúr-Réti-dűlő site, Grave 13; front view and side view; top view and rear view (©Dániel Gerber)

taken at the Medical Imaging Centre of Semmelweis University, and then, the plastic copy was made by Varinex Inc. using selective laser sintering technology *(fig. 5)*.

The features of the skull

The characteristics of the skull foreshadowed the features of the reconstructed face *(fig. 4)*. The skull is small in absolute size, fine-boned, and feminine. According to the cranial (length-breadth) index, the skull is short and low, the forehead is narrow and convex. The occiput is curved, the muscular joints *(linea nuchae superior et suprema)* are prominent, the external occipital protuberance *(protuberantia occipitalis externa)* is well-developed, and although the mastoid process *(processus mastoideus)* is small, the neck muscles must have been quite strong. The nasal cavity is medium wide *(mesorrhin)*, the lower edge is sharp *(anthropin)*, which together suggest nasal wings of medium width. The nasal root is shallow and the bony part of the nasal dorsum is straight. The distal end of the nasal bones was broken, so we completed it with wax. The anterior

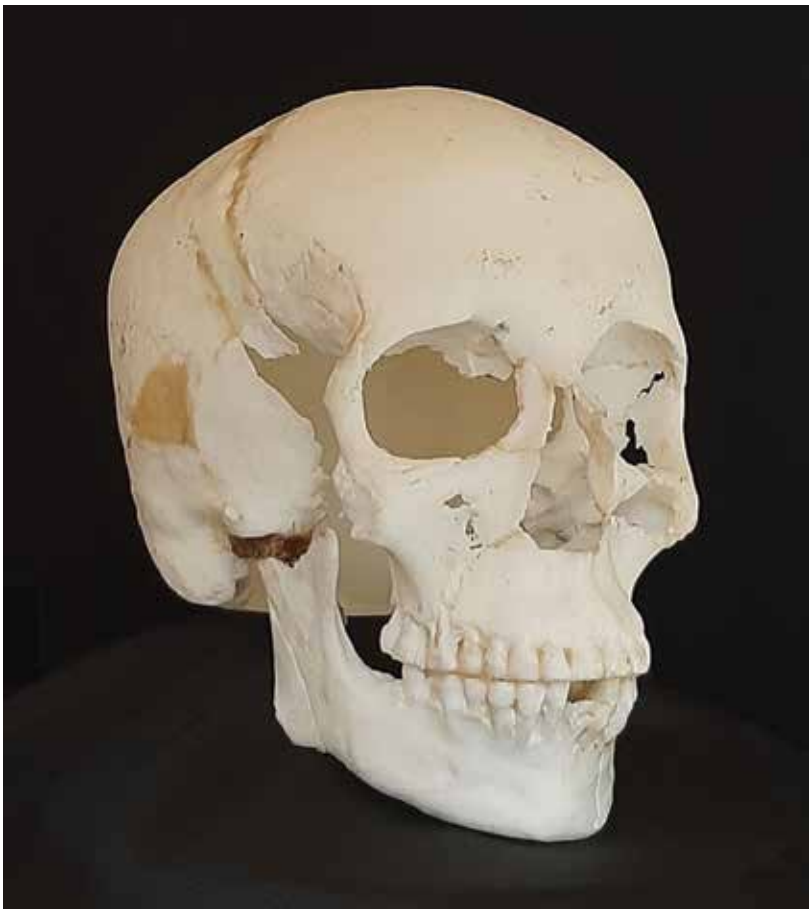

Fig. 5. The plastic copy of the skull of the Bronze Age woman from Balatonkeresztúr-Réti-dűlő site, Grave 13 in 3D made with selective laser sintering (SLS) technology (©Varinex Inc., ©Ágnes Kustár)

nasal spine *(spina nasalis anterior)* is mid-sized, turned slightly upward, which, along with the nasal bones moderately protruding from the plane of the face, is suggestive of a moderately protruding cartilaginous ridge of the nose *(nasus externus)*.

The orbital cavities are medium high *(mesokonch)*, rounded in shape, and have slightly inverted upper edges. The distance between the two orbital cavities is relatively small. The zygomatic bone is low and smooth, the zygomatic arch is slender, and the canine fossa *(fossa canina)* is shallow. It is characteristic that because of the prognathism *(prognathia)* of the alveolar processes of both the upper jaw *(maxilla)* and lower jaw *(mandibula)*, the front teeth protrude considerably. As a result, the lips are expected to be rather full and also protruding. The lower jaw *(mandibula)* is small and low; the body *(corpus)* of the mandible is medium thick. The ramus of the mandible *(ramus mandibularis)* is low, the condylar heads of the mandible are small, yet the mandibular notch is nearly rectangular with a moderately developed muscle adhesion surface. The chin is slightly protruding, tapering towards its point. The triangular eminence of the chin *(trigonum mentale)* is pointed.

The process of facial reconstruction

During the facial reconstruction, we rebuilt the soft tissues of the face on the plastic skull based on the shape of the bones so that they would faithfully reflect the original facial features. The reconstruction of the face was made with a traditional sculptural anatomical technique following

scientific methodological guidelines.[29] The muscles modelled from plastiline were rebuilt onto the bones according to their real attachment points.[30] The thickness of the muscles was estimated from the roughness of the bone surface measured at 45 points of the skull and using a table of scientifically collected data.[31]

First, the measuring pins (markers) indicating the thickness of facial muscles and other soft tissues were fixed at 45 points on the plaster copy of the skull. The lengths of the markers were set according to the values of average soft tissue thickness as indicated in *Table 1.* Long pins were used to mark important morphological points (the corners of the eyes and mouth, the orifice between the lips) that would disappear under the layers of plastiline during modelling.

The eyes were replaced with eyeballs made of synthetic resin of a size (25 mm) that fit the eye sockets. The septal nasal cartilage *(septum nasi cartilagineum)* was constructed of harder wax to preserve the shape of the external part of the nose while modelling. The ridge of the nose and the cartilage of the tip of the nose were made of plastiline. The size of the external nose and the position of the tip of the nose were inferred from the shape of the nasal bones, the proportions of the nasal cavity, and the direction of the nasal spine.[32] The course and thickness of the mimetic muscles were reconstructed from the attachment of the muscles to the bones. We first reconstructed the deeper-lying muscles and then the upper muscle layer based on anatomical normalities, taking into account the unique characteristics of the bones *(figs. 6–7).*

In the 'sculpting phase' of facial reconstruction, we modelled the details of the face. The principles of sculptural form helped the harmonious fitting of the parts of the face and their shaping into an organic whole.

The features of the reconstructed face

The reconstructed head shape faithfully reflects the shape of the skull. The head is broad and short. The forehead is narrow and convex. The *glabella* (the area between the eyebrows) and the brow ridges are a little prominent and slightly arched. The face has a medium width, tapering towards the mental protuberance. The neck is relatively strongly built.

The nasal root is moderately deep, while the nasal ridge is quite prominent and has a straight line. Due to the slightly rising nasal spine, the tip of the nose is turned somewhat upward, and it is tapering. In the frontal view of the face, the nasal root is narrow, the nasal ridge and the wings of the nose are medium broad. Based on the location of small eminences *(tuberculum palpebrale)* indicating where the medial and lateral palpebral ligaments *(ligamentum palpebrale mediale et laterale)* joined the inner and outer edges of the eye cavities *(orbita)*, the eye slits are horizontal. The eyes are located rather close to each other, with a medium-thick fold over the eyelids. The mouth is medium wide and quite full. Due to the protrusion of the front teeth, the lips are also protruding, and the upper incisors stick out a bit. The jaw is not pronounced, the mental eminence is slightly protruding. The unique characteristics of the ears cannot be seen on the skull, so the dimensions of the ears have been adapted to those of the nose and their shape is harmonious with other features of the face *(fig. 8).*

The nutritional status cannot be inferred from the surface of the bones, either. We modelled the face assuming moderate nutrition.

The middle-aged woman lived for about 35-45 years, so on the reconstructed face – mainly on the forehead and at the nasal root – we already indicated the mimetic wrinkles typical of individuals of the mature *(maturus)* age group (40–60 years).

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[29] *Gerasimov 1949; Gerasimov 1971; Taylor 2000; Prag – Neave 1997.*

[30] *Kustár – Skultéty 1996* 179–190; *Sjøvold 1981* 203–204.

[31] *Röhrer-Ertl – Helmer 1984* 369–398.

[32] *Rynn – Wilkinson 2006* 364–373.

Measuring point	Degree	Thickness (mm)
Bregma (b)	1	4
Metopion (m)	1	4
Glabella (g)	1	5
Nasion (n)	1	4
Rhinion (rhi)	1	2
Philtrum (ph)	1	7
Labiomentale (lab)	1	7
Pogonion (pog)	1	8
Gnathion (gn)	1	7
Arcus sup.medialis (acm)	1	7
Arcus sup.lateralis (acl)	1	4
Ectoconchion (ek)	1	3
Orbitale (or)	1	3
Dacryon (da)	1	2
Lacrimale (la)	1	2
Lat.apertura pir. (lat.ap)	1	2
Alare (al)	1	3
Subspinale lat. (ss lat)	1	9
Caput mandibulae (cap)	1	3
Gonion (go)	2	4
Zygion (zyg)	1	2
Facies zygomaticus (fac.zyg)	1	4
Zygomaxillare (zm)	1	3
Proc.mastoideus (mast)	1	3
Lambda (l)	2	5
Opisthocranion (op)	2	5
Subnasale (sn) (H11)*		13
Labrale superius (ls)(H12)*		11
Labrale inferius (li)(H13)*		12
Mid mandibular border (mmb)(H28)*		11.5
Euryon (eu)(H29)*		5.5

Grades according to bone relief : 1. Very gracile, smooth
2. Less gracile, a little rough
3. Rough
4. Robust, very rough

* H11-H29 measurements according to Helmer (1980 in *Röhrer-Ertl – Helmer 1984*)

Table 1. The thickness data of soft tissues on the skull from Balatonkeresztúr-Réti-dűlő site, Grave 13

Fig. 6. a. The pins indicating the thickness of soft tissues were fixed on the plaster copy of the plastic skull from Balatonkeresztúr-Réti-dűlő site, Grave 13, and the eyes were replaced with plastic eyeballs (©Dániel Gerber); b. The muscles of mastication, the upper lips, and the external nose were modelled from plastiline. The corners of the mouth were marked with long needles (©Dániel Gerber)

Fig. 7. The reconstructed muscles of the right side of the face, already covered with skin. On the left side of the face, the layers of the mimetic muscles are still visible: the complex circular muscle around the orifice of the mouth and forming the majority of the lips *(m. orbicularis oris)*, and the mimetic muscles radiating into the mouth (from above: *m. levator labi superioris alaeque nasi, m. zygomaticus minor et major;* from below: *m. mentalis, m. depressor labi inferioris, m. depressor anguli oris*) (©Dániel Gerber)

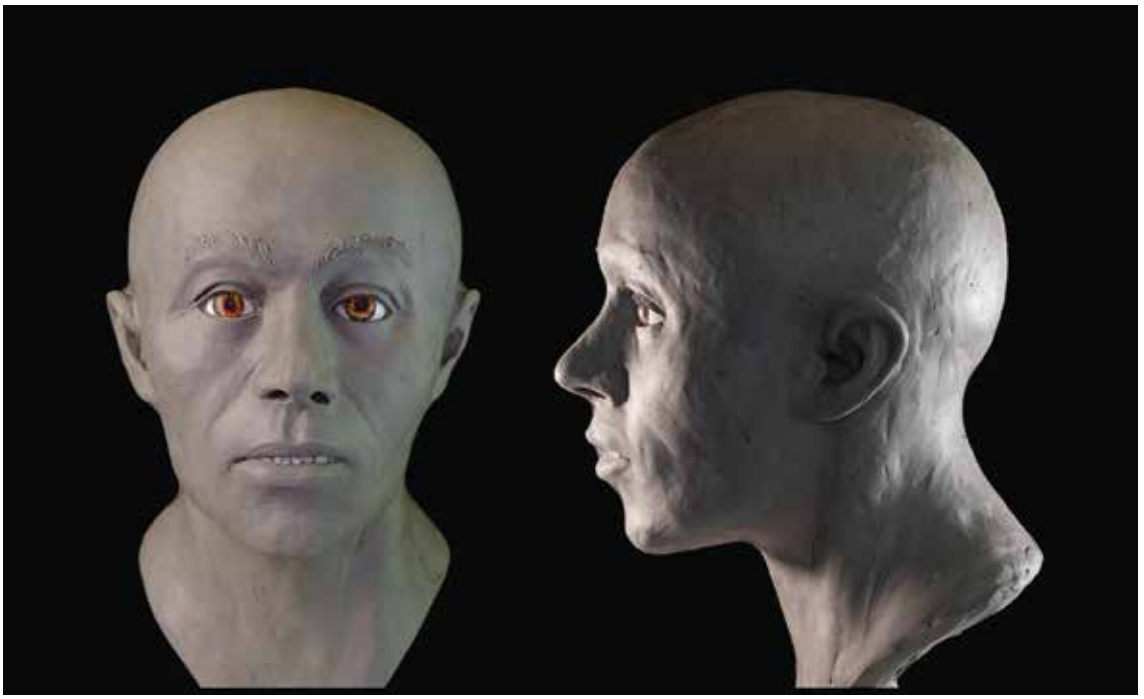

Fig. 8. The finished facial reconstruction of Balatonkeresztúr-Réti-dűlő, Grave 13; front view and side view (©Ágnes Kustár, ©Dániel Gerber)

Fig. 9. The plaster cast with lifelike colouring for the purpose of facial reconstruction from Balatonkeresztúr-Réti-dűlő, Grave 13 and with hair made of a wig; front view, side view (©Zsuzsa Herceg, ©Dániel Gerber)

Fig. 10. Lifelike coloured facial reconstruction of the woman called Jelena from Balatonkeresztúr-Réti-dűlő, Grave 13, half profile (©Ágnes Kustár, ©Zsuzsa Herceg, ©Dániel Gerber)

Phenotypic characteristics: eye colour, hair colour, and skin tone

Genetic data suggest creole-toned, freckled skin and light, bluish eyes with multiple brown pigments. The eyes, the lifelike skin colouring, and the reconstruction of the hair were prepared by restorer Zsuzsa Herceg accordingly *(figs. 9–10)*. The hairstyle was made of a darker-toned blondish brown wig with a braid of hair based on the depictions of contemporary women's fashion.[33]

Conclusions

Recent research has revealed that, in the beginning, the communities of the Early Bronze Age Kisapostag/Earliest Encrusted Pottery culture used inhumation to bury the dead. They placed the deceased in the grave on their sides in a sleeping position, with their legs pulled up, often without any grave goods. Less frequently, they put a small beaker next to the head and decorated the body with small pieces of jewellery (tiny tubular beads made of sheet copper and hair rings). In a later period of the culture, cremation burials became more and more dominant.[34] The graves of the twelve individuals arranged in two groups at the Balatonkeresztúr site followed inhumation burial rites mentioned above. The woman around the age of 35-45 years discovered in Grave 13 presented in our paper was buried in a slightly different position from the other deceased. According to radiocarbon tests, her burial most probably took place between 2040 and 1890 BC. Based on the data of the anthropological analysis, she must have been approximately 159 cm tall, which can be considered the average height of females in this era. Of her 29 preserved teeth, only one was affected by dental caries. There was no sign of an external injury or illness on her body, so the cause of her death is currently unknown. Copper or bronze bead fragments associated with the headdress or cap ornament found in the grave suggest that she had a relatively high social status within the community living at the settlement.

The composition of the nuclear genome of the woman called Jelena by our research team fits into the dataset available so far on the population of the Kisapostag/Earliest Encrusted Pottery

[33] *Kiss 2019* fig. 4. 5, 11.

[34] *Somogyi 2004; Szabó 2010; Kiss 2012; Hajdu et al. 2016; Kiss 2020a.*

culture. At the same time, the increased hunter-gatherer ancestry of her group is unique in this period, which clearly differentiates this community from the hitherto known Bronze Age populations of Europe.[35] In terms of family ties, Jelena did not have any first-degree relatives at the site, only possible second-degree relations among the deceaseds at Balatonkeresztúr.[36] Concerning her phenotypic characteristics, despite her steppe links, she was more similar to the Neolithic[37] people known so far: her skin was rather creole-coloured and had brownish blond hair of a darker shade. Her face may have been freckled, and her eyes were determined by genes responsible for both blue and brown pigmentation.[38]

The delicate-boned feminine skull, preserved in very good condition, allowed us to carry out the reconstruction of the woman's facial features. This was the first female facial reconstruction from the Bronze Age in Hungary. The completed work is also unique from the aspect that this was the first time in the history of Hungarian archaeological investigations when phenotypic features revealed by genetic analyses could be incorporated into the reconstruction. During the facial reconstruction, the soft tissues of the face were added to a plastic skull made with 3D printing technology after the CT image of the original skull to reflect the former facial features faithfully. The reconstruction of the face was carried out with traditional methods used in sculpture and anatomy following scientific methodological guidelines. The extent of nutrition could not be inferred from the surface of the bones, so we assumed normal nutrition, and modelled the face accordingly. On the reconstructed face – primarily on the forehead and at the nasal root – we already indicated mimetic wrinkles characteristic of mature people. The hair was braided in accordance with women's fashion reflected by contemporary clay figurines. The lifelike facial reconstruction allows us to get to know the face of a Bronze Age woman first time in Hungary, who lived near Lake Balaton four thousand years ago.[39]

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[36] *Gerber et al. preprint*, Supplementary Material fig. S.2.3.3.
[37] *Mathieson et al. 2015.*
[38] *Gerber et al. preprint.*
[39] The processing of the burial and the facial reconstruction were carried out with the support of the Lendület/Momentum programme of the Hungarian Academy of Sciences, in the frames of the Lendület/Momentum Mobility Research project "From Bones, Bronzes, and Sites to Society: Multidisciplinary Analysis of Human Mobility and Social Changes in Bronze Age Hungary (2500–1500 BC)" (LP2015-2). We owe special thanks for the Medical Imaging Centre of Semmelweis University for the CT scan of the skull, and for restorer Zsuzsa Herceg for the lifelike colouring of eyes, and skin, and the reconstruction of the hair.

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