INSTITUTE OF ARCHEOLOGY
AND ART HISTORY OF ROMANIAN
ACADEMY CLUJ-NAPOCA

UNIVERSITATEA TEHNICĂ
DIN CLUJ-NAPOCA

JAHA
JOURNAL OF ANCIENT HISTORY
AND ARCHAEOLOGY

editura
MEGA

Journal
of Ancient History and Archaeology

Scopus
Clarivate Analytics
Central and Eastern European Online Library
EBSCO
Crossref
creative commons
Google scholar
ERIH PLUS
EUROPEAN REFERENCE INDEX FOR THE HUMANITIES AND SOCIAL SCIENCES
DOAJ DIRECTORY OF OPEN ACCESS JOURNALS

No. 12–3/2025

CONTENTS

STUDIES

ANCIENT HISTORY

Serkan DEMIREL
HORSES IN HITTITE SOCIETY: STATUS, SYMBOLISM AND UTILITY.....3

Stanislav GRIGORIEV
THRACIANS IN THE EAST. CULTURAL TRANSFORMATIONS IN THE LATE BRONZE AGE OF KAZAKHSTAN.....13

Erdal KAYA
LEGIONARY GARRISON AND AUXILIARY FORTS OF THE ROMAN EMPIRE IN ARMENIA MINOR.....39

Mihaela IACOB, Daniela Florina LUNGU, Flavia Maria BARBU, Constantin Viorel MARIAN
MUNICIPIUM *NOVIODUNUM* (IN MOESIA INFERIOR) DURING THE PRINCIPATE PERIOD: ARCHAEOLOGICAL PRESENTATION USING COMPUTER SOLUTIONS, EPIGRAPHIC AND NUMISMATIC DOCUMENTATION.....55

ARCHAEOLOGY

Cristian Ioan POPA
CUGIR III BRONZE HOARD. AND SOME ADDITIONS REGARDING THE BRONZE HOARDS FROM CUGIR.....72

Zhuldyzay KISHKENBAYEVA, Sergey YARYGIN, Sergazy SAKENOV
IMAGES IN THE SAKA ANIMAL STYLE OF TAUSAMALY (EASTERN ZHETYSU REGION, KAZAKHSTAN).....101

Jerónimo SÁNCHEZ-VELASCO, Leticia TOBALINA-PULIDO
THE LATE ROMAN MAUSOLEUM OF SÁDABA (ZARAGOZA, SPAIN). NEW SCIENTIFIC INTERPRETATIONS OF THE MONUMENT.....118

ARCHAEOLOGICAL MATERIAL

Roxana CIRȚ
POST-FIRING INTERVENTIONS ON LA TÈNE POTTERY FROM THE EASTERN CARPATHIAN BASIN: MENDING PRACTICES.....129

Alexandru BERZOVAN, Bogdan PETRU, NICULICĂ, Constantin APARASCHIVEI
REVISITING OLDER DISCOVERIES. THE LATE IRON AGE FINDS FROM BOSANCI AND VORNICENII MICI (SUCEAVA COUNTY).....144

Hasan Ertuğ ERGÜRER, Deniz Berk TOKBUDAK
A NEW ROMAN IMPERIAL PORTRAIT FROM SYEDRA.....155

Aleksandr SYMONENKO
THE TERRA SIGILLATA TABLE AMPHORAE AMONG NORTH PONTIC BARBARIANS OF ROMAN AGE.....162

Dávid PETRUȚ, Sorin COCIȘ
DOMESTIC LIGHTING IN ROMAN NAPOCA (II). LAMPS DISCOVERED ON VARIOUS SITES IN AND AROUND THE ROMAN CITY (CLUJ-NAPOCA, ROMANIA).....170

Salih SOSLU
A GROUP OF GOLD EARRINGS FROM BURDUR MUSEUM AND ARCHAEOMETRY ANALYSIS (TÜRKIYE).....184

Fevziye EKER, Kasım EKER
A GROUP OF BOTTLES FROM THE LATE ANTIQUE GLASS COLLECTION OF TOKAT MUSEUM.....200

ARCHAEOLOGICAL MATERIAL AND REPORTS

Radu OTA, Ilie LASCU
ARCHAEOLOGICAL RESEARCH IN CANABAE/MUNICIPIUM SEPTIMIUM APULENSE-SOUTHERN SECTOR.....206

ARCHAEOLOGICAL MAPPING

Ana ODOCHICIUC, Alin MIHU-PINTILIE, Lucrețiu MIHAILESCU-BÎRLIBA
MAPPING HINTERLAND RESOURCES IN THE RURAL LANDSCAPE OF GREEK POLEIS ISTROS AND TOMIS DURING THE ROMAN PERIOD.....225

ARCHAEOMETRY

Ioan Alexandru BĂRBAT, Corina Anca SIMION, Tiberiu Bogdan SAVA, Oana GÂZA, Cristian MĂNĂILESCU, Maria Valentina ILIE
DISCOVERING A NEW EARLY STARČEVO-CRIȘ SITE IN SOUTHWESTERN TRANSYLVANIA AT FOLT-*SUB VII* (HUNEDOARA COUNTY, ROMANIA) AND A PROCEDURE FOR DATING EARLY NEOLITHIC SHARD SAMPLES.....243

EPIGRAPHY AND PAPYROLOGY

Peter ROTHENHÖFER, Florian MATEI-POPESCU
A NEW FRAGMENT OF A MILITARY DIPLOMA FOR THE *EQUITES SINGULARES AUGUSTI*.....256

Ioan PISO, Sorin COCIȘ, Vlad-Andrei LĂZĂRESCU, Sergiu-Traian SOCACIU
TWO ROMAN INSCRIPTIONS FROM JIBOU, SĂLAJ COUNTY.....259

NUMISMATICS

Cristian GĂZDAC, Claudiu PURDEA
NUMISMATICS AND FORENSICS: OPERATION DACIAN GOLD. THE HOARD GRĂDIȘTEA DE MUNTE – 'TIMIȘOARA AIRPORT'.....266

KASIM OYARÇİN, YAVUZ YEĞİN
AN EVALUATION OF THE OLBA NYMPHAEUM AND COINS.....294

REVIEWS

Dan DEAC
Isis, Sarapis And The Waves Of The Black Sea. V. Atanassova, L. Bricault (eds.), *Egyptian Cults on the Black Sea Coast / Египетските култове по крайбрежието на Черно море*, Institute of Balkan Studies with Center of Thracology, Bulgarian Academy of Sciences / École française d'Athènes Sofia, ISBN 978-619-7179-45-3; ISBN 978-2-86958-630-7, "Paradigma" Publishing House, 2024, 194 p.....304

ISSN 2360 266x
ISSN–L 2360 266x

Design & layout: Francisc Baja

editura MEGA

Editura Mega | www.edituramega.ro
e-mail: mega@edituramega.ro

A GROUP OF GOLD EARRINGS FROM BURDUR MUSEUM AND ARCHAEOMETRY ANALYSIS (TÜRKIYE)

Salih SOSLU
Burdur Mehmet Akif Ersoy University, Burdur, Turkey
ssoslu@mehmetakif.edu.tr

Abstract: The aim of this study is to examine a group of gold earrings in Burdur Museum from a typological and analogical perspective and to share the archaeometric analysis data of these earrings. The atifacts were added to the museum inventory through purchase. 12 of the examined artifacts are gold, one is gold plated on bronze, and one is gold plated on glass. 13 of the artifacts are earrings and 1 is an earring pendant: Of these artifacts, Cat. No. 1–12, 14 are hoop shaped. Cat. No. 1–4, 14 artifacts have simple hoop shaped. Cat. No. 13 is a pendant. These artifacts are defined as head jewellery.
Since it was not possible to take pieces from the artifacts or use destructive methods in the analysis of the artifacts, the analyses were carried out using non-destructive methods. Three analysis methods were applied: P-EDXRF, X–ray Radiography and μ-PIXE. The numerical data of these analyses were examined and the data were obtained using the statistical analysis method SPSS. The analysis covers topics such as the use of pure gold and gold ore, chemical components of alloys, color differences resulting from the combination of gold with silver and copper alloys, alloys used in plating and copper ratios used in soldering.

Keywords: *Burdur Museum, Gold Jewellery, P-EDXRF, X–ray Radiography and X–ray μ-PIXE.*

INTRODUCTION

In ancient times, wealth, fashion and personal desires were at the forefront in the selection and use of jewellery forms. It is known that earrings, necklaces, bracelets, rings, crowns, fibulas and chained chest jewellery are widely preferred among the jewellery types frequently used by women.[1] Among these, the most important and evaluated jewellery group in terms of our subject is the earring.

In this study, 14 gold earrings belonging to Burdur Museum were examined.[2] The artifacts were brought to the museum through purchases. It is defined as head jewellery. It has been examined in two main typologies

[1] WILLIAMS/OGDEN 1994, 33.

[2] We would like to thank Burdur Museum Director Murat Kaleağasıoğlu for allowing the examination and publication of the gold jewellery included in this study (the official permit dated 31/01/2023 and numbered E–51544244–155.01–3441393). Dr. Çetin Görür (Van Yüzüncü Yıl University, Türkiye) and Dr. Aykut Kabak (Van Yüzüncü Yıl University, Türkiye), who determined the numerical data of the artifacts with the statistical analysis method SPSS; Prof. Dr. Rıdvan Karapınar (Burdur Mehmet Akif Ersoy University, Türkiye) for his support in interpreting the analysis of the artifacts.

according to its forms: Hoop earrings are evaluated as closed and opened hoop earrings. There is one pendant. They are produced using wire, filigree, engraving, sheet, casting, plating and granulation techniques. The earrings date back to the Roman Imperial period based on their model features.

Since it was not possible to take pieces from the artifacts or use destructive methods in the analysis of the artifacts, the analyses were carried out using non-destructive methods. Three analysis methods were applied: P-EDXRF, X–ray Radiography and μ-PIXE.

This study was prepared with two purposes in mind. The first purpose is to examine a group of gold earrings in Burdur Museum from a historical and archaeological perspective, to determine their functions, purposes of use, forms and production techniques and to create a catalogue in line with the obtained data. The second purpose of the study is to determine their chemical alloys by performing archaeometric analyses.

The importance of this study is to identify gold earrings by analyzing them with micro-analytical and non-destructive analysis systems such as P-EDXRF,[3] X–ray Radiography[4] and μ-PIXE[5] and to create a catalogue for their introduction to the Anatolian ancient gold jewellery culture. For this reason, such studies, in which the Burdur Museum gold group is examined and its archaeometric analysis is carried out, will both make gold jewellery studies more qualified and provide information about the technology of the jewellery field in the historical process through their analyses.

HISTORICAL DEVELOPMENT OF EARRINGS IN ANCIENT GOLD JEWELLERY ART

The first earrings made of gold appeared in the 4th millennium BC. The earliest examples are in the Athens,[6] Varna[7] and Benaki[8] museums. It is a centre in Anatolia where gold earrings dating back to the 3rd millennium BC were found;[9] Alacahöyük, Eskiyapar and Troy II are also important settlements where earrings were found.[10] It is also noteworthy that the diversity in form and production techniques in gold earrings dating from the end of the 2nd millennium BC to the beginning of the 1st millennium BC has increased. The earrings dating back to the 1st millennium BC consist of a "semicircular C form" body. Thin wire was used in their production. Spiral decorations depicting grape clusters formed from spheres were encountered using the granulation technique.[11] Archaic and Classical periods earrings are more sumptuous products. The earrings produced with sheet, chain, granulation and embossing techniques in spiral, circle, crescent, sandal, pyramid and spool shapes are common. Depictions of gods (eros) and goddesses (medusa), mythological characters (ganymedes, nereid), human and animal figures (lion) and plants (palmette) were frequently used.[12] In the Hellenistic period, hoop, rosette, pendant, spiral, crescent and pyramid earrings produced using wire, engraving, granulation, casting and sheet techniques were widely preferred. It is seen that stone earrings (precious and semi-precious) have also started to be produced.[13] The widespread use of simple hoop earrings attracts attention during the Roman Imperial period. When we look at earring making techniques in the 1st–2nd centuries AD casting, wire, solid wire, granulation, engraving, sheet and mold techniques were preferred;[14] while in the 2nd century AD large spiral twisted earrings were preferred.[15] In the 2nd–3rd centuries AD earrings with disc rings and pendantless,[16] earrings with square rings and pendantless,[17] "S" shaped hoop earrings[18] and conical shaped earrings with pendants were widely produced using wire and granulation techniques.[19] In the 4th–5th centuries AD the production of hoops-shaped earrings with or pendantless using wire, engraving, coating and granulation techniques was quite common.[20] Also, cresent-shaped earrings were produced using wire, sheet, carving and openwork and granulation techniques between the 6th–7th centuries AD[21] and the 10th century AD.[22]

STUDY SUBJECT GOLD EARRINGS (FIG. 1 (CAT. NO. 1–14))

In this study, 14 gold artifacts were examined: 12 of these artifacts are made of gold (Cat. No. 1–9, 11–12, 14), one is gold-plated on bronze (Cat. No. 10) and one is gold-plated on green matt glass (Cat. No. 13). Of these artifacts, Cat. No. 1–12, 14 are hoop shaped. Cat. No. 1–4, 14 artifacts have simple hoop shaped. Cat. No. 13 is a pendant. The hook or hoop part of this artifact has not been found.

The artifacts were examined in 2 groups according to the hoop type. Group 1: closed hoop earrings (Cat. No. 1–9, 11–12, 14). Group 2: open hoop earrings (Cat. No. 10). The closed hoop earrings are divided into 2 groups as pendant (Cat. No. 8–9, 12) and pendantless (Cat. No. 1–7, 11, 14).

[3] POTTS/WEST 2008, 55–56.
[4] SCHREINER *et alii* 2004, 1–17.
[5] HALDEN/CAMPBELL/TEESDALE 1995, 293–302.
[6] PAPAGEORGIY 2003, 213, no. 3.
[7] KRAUß *et alii* 2017, 282–305.
[8] PAPAGEORGIY 2003, 215, no. 7.
[9] TURE/SAVASCIN 2000, 25.
[10] DUCHENE 1995, 1–9.
[11] MARSHALL 1911, 23–24, Pl. III, no. 322–323, 348; 27–30, Pl. IV, no. 470, 488, 501, 510, 512, 538; BINGOL 1999; MERICBOYU 2001; ZIMMERMANN 2016, 8.
[12] WILLIAMS/OGDEN 1994, 57, no. 9; 76, no. 31; 87, no. 38; 91, no. 43; 94. no. 46; 95, no. 47–8; 131, no. 75; 198, no. 132; 247, no. 177.
[13] HOFFMAN/DAVIDSON 1965, 84, Fig. 13; 88, no. 15a; 91, no. 16; 94, 18a; 95, no. 19a; 98, no. 21a; 104, no. 24; 105, no. 25; 108, no. 29; 109, no. 30; 111, no. 32; 287, no. 137; JULIIS 1984, 153, no. 63–5; 160, no. 73; 164–6, no. 78–80; 168–171, no. 83–86; 177, no. 100.
[14] GREIFENHAGEN 1975, Pl. 49/11–13; MILOVANOVIC 2018, 120, no. 17.
[15] MILOVANOVIC 2003, 134, Pl. 2, IIIb1; FACSÁDY 2008, 239, Fig. 1, no. 1c; MULLER 2010, 345, Taf. 98, 1–13, 135/24.
[16] MARSHALL 1911, 292, Pl. LIII, no. 2508; MILOVANOVIC 2003, 14, no. IVa; 2018, 120, 17; MULLER 2010, 311, Taf. 64, 1–5, 15/11.
[17] MARSHALL 1911, 282, Pl. LII, no. 2394, 2396; FACSÁDY 2008, 239, Fig. 1, no. IVb; MILOVANOVIC 2018, 123, Fig. 22.
[18] MARSHALL 1911, 281, Pl. LII, no. 2376; FACSÁDY 2008, 240, Fig. 5.
[19] MARSHALL 1911, 284, Pl. LII, no. 2412, 2417; STERN 1990, 148, Pl. 30, no. 696.
[20] MILOVANOVIC 2003, 134, Pl. 2, no. Ib; FACSÁDY 2008, 239, Fig. 1, no. IIIc; Fig. 1, no. 1b; MULLER 2010, 279, Taf. 31, 76, 6/7; UYGUN 2021, 228, Fig. 18.
[21] SRIBAR/STARE 1974, 463, no. 6; BOLLÓK 2010, 182, Pl. 2, no. 11; GERMANA 2019, 3, Fig. 3; SCHULZE-DORRLAMM 2020, 24, 30, no. 19, 25.
[22] LANGO 2010, 372, 1d; BOLLÓK 2010, 182, Pl. 2, no. 2; KALAMARA 2013, 266, no. 141; POSSENTI 2019, 296, no. 6; GERMANA 2019, 7, Fig. 7a.

The pendant earrings are divided into 2 groups as applique (Cat. No. 8–9) and without applique (Cat. No. 12). Earrings with appliques are divided into 2 groups: earrings with square appliques and drop-shaped pendants (Cat. No. 8) and earrings with rosette appliques and wire pendants (Cat. No. 9). There is an earring example without an applique. It has a spherical pendant (Cat. No. 12).

The earrings pendantless are divided into two groups: with appliques (Cat. No. 5–7, 11) and without appliques (Cat. No. 1–4, 14). The applique earrings feature stylized grapes (Cat. No. 5), rosettes (Cat. No. 6), pyramidals (Cat. No. 7), and wire decorations (Cat. No. 11).

There is an example of an open hoop earring: with wire applique and pendantless (Cat. No. 10).

Closed Hoop Earrings (Cat. No. 1–9, 11–12, 14)

Cat. No. 1 artifact was made in wire technique. This artifact is a simple hoop earring and pendantless. It is without applique. The earring is single. One end of the thick wire is wrapped twice around itself to form a large double loop, and the loop end is wrapped four times around the body. The other end, tapering towards the attachment point, is wrapped twice around a short hook hoop. Similar examples were found in the necropolises of Pecine,[23] Juliopolis,[24] Bölcek[25] and Eski Şamlar,[26] as well as Andriake[27] and Archaeological Museum of İznik[28] and are dated to the 2nd–4th centuries AD.

Cat. No. 2–4 artifacts were made with wire and engraving techniques. Cat. No. 2 artifact is a simple hoop earring and pendantless. It is without applique. The earring is single. One end of the thick wire is wrapped around itself twice to form a small double loop and the loop end is wrapped around the body six times. The other end, tapering towards the attachment point, is wrapped once around the long hook hoop. There is a small ring on the body and a groove decoration. There are short scratches on the surface as a result of the engraving process. Cat. No. 3 artifact is a simple hoop earring and pendantless. It is without applique. The earring is pair. One end of the thick wire is wrapped twice around itself to form a small double loop, and the loop end is wrapped seven times around the body. The other end, tapering towards the attachment point, is wrapped once around the long hook hoop. The body is grooves decorated. Cat. No. 4 artifact is a simple hoop earring and pendantless. It is without applique. The earring is pair. One end of the thick wire is wrapped twice around itself to form a small double loop, and the loop end is wrapped five times around the body. The other end, tapering towards the attachment point, is wrapped once around the long hook hoop. There are two small rings on its body and it is grooved. It similar examples are in the cities of Amisos,[29] Cibyra,[30] Patara[31] and Perge,[32] in the museums of Silifke,[33] Tokat[34] and Adana,[35] the Museum of Anatolian Civilizations,[36] as well as in the Berlin Prussian Cultural Heritage State Museums[37] and the British Museum.[38] It dates back to the 1st–3rd century AD.

Cat. No. 5 artifact was made with wire and granulation techniques. It is a hoop earring and pendantless. The earring is single. Both ends of the thick wire are of equal thickness towards the connection point. It is an applique earring and stylized grapes are used as decoration. The outer side of the lower half of the earring is decorated with a grape cluster made of small spheres made with the granulation technique. Two of the clusters were intact, while the other two were found to be missing from the remains on the earrings. The similar examples are found in the Burdur Museum,[39] Alaşehir,[40] Mikulčice,[41] the Museum of Anatolian Civilizations,[42] the British Museum[43] and in the tomb with a worked edge in Keszthely-Fenékpuszta.[44] It dates back to the 2nd century AD.

Cat. No. 6 artifact was made with casting and wire techniques. It is a hoop earring and pendantless. The earring is pair. One end of the thick wire was wrapped around itself once to form a single loop and the loop end was wrapped twice around the body. The other end, which tapers towards the connection point, is wrapped twice around a short hook hoop. It is an applique earring and rosette is used as decoration. The earring has a flat base and a rosette on the upper part, made with a curved profile casting technique. A similar earring was found in Tomb 66 at Viminacium[45] and dates to the 2nd century AD.

Cat No. 7 artifact was made with wire and casting techniques. It is a hoop earring and pendantless. The earring is double. One end of the thin wire is wrapped once to form a short loop and the loop end is wrapped twice around the body. The other end, which tapers towards the connection point, is wrapped once around the short hook hoop. It is an applique earring and pyramidal is used as decoration. The base of the hoop is flat and a pyramid-shaped ornament is soldered to its outer part. It similar examples are found in Kütahya,[46] Uşak-Kula,[47] Patara,[48] in the tomb in Aquincum,[49] in Pirivoj Tomb 313 in Viminacium,[50] in the Tokat Museum[51] and in the British Museum.[52] They date back to the 2nd–3rd century AD.

Cat. No. 8 artifact was made using casting, wire and sheet

[23] MILOVANOVIC 2003, 133, Pl. 2, IIa.
[24] ARSLAN *et alii* 2011, 287, 291, Fig. 3.
[25] TURKTUZUN1990, 44, Fig. 7.
[26] YUCE 1994, Fig. 9, 93/3.
[27] TALU 2020, 162, 165, cat. no. 4, 6.
[28] KAYA *et alii* 2024, 185, Fig. 5a-b.
[29] SIRIN/YIGITPASA 2021, 209, Fig. 32, cat. no. 32.
[30] SIMSEK 2022, 674, 677–678, cat. no. 267–268, 274–275.
[31] UYGUN 2000, 100, Pl. 23, K11.
[32] OZGULNAR 2007, 76, cat. no. 2.
[33] ERTEN 2018, 15, Fig. 5.
[34] GORAL 2019, 127, cat. no. 11.
[35] ATAKURU 2020, 56, cat. no. 3.
[36] BINGOL 1999, 71, cat. no. 46.
[37] ADOLF 1975, 62, Pl. 49, no. 10.
[38] MARSHALL 1911, 289, Pl. LIII, no. 2464.
[39] SOSLU/SOSLU 2024, 41, cat. no. 5.
[40] BINGOL 1999, 69, cat. no. 42.
[41] UNGERMAN 2020, 285, Fig. 182.1.
[42] SEZGIN 2014, 89, no. 82.
[43] MARSHALL 1911, 300, Pl. LIV, no. 2596.
[44] MULLER 2010, 296, Taf. 49/12.
[45] MILOVANOVIC 2018, 119, no. 16.
[46] TURKTUZUN 1991, 244, Fig. 25.
[47] BINGOL 1999, 74, cat. no. 52.
[48] UYGUN 2000, 103, Pl. 25, no. K16.
[49] FACSÁDY 2008, 239, Fig. 1, no. IVb.
[50] MILOVANOVIC 2018, 123, Fig. 22.
[51] GORAL 2019, 145, no. 36.
[52] MARSHALL 1911, 282, Pl. LII, no. 2394, 2396.

techniques. It is a hoop earring and has a pendant. The earring is single. One end of the thin wire is wrapped once to form a short hoop, and the hoop end is wrapped once around the body. The other end, tapering towards the attachment point, is wrapped once around the short hook hoop. In the earring is the with square applique and drop-shaped pendant. A flat-based square pyramid is soldered to the outer surface of the hoop, and a drop-shaped pendant is soldered to the hoop. It similar examples can be found in the cities of Patara[53] and Perge,[54] in the Istanbul Archaeological Museum,[55] in the Berlin Prussian Cultural Heritage State Museums,[56] and in Tomb 1166 in Qasrawet (North Sinai).[57] It dates to the 2nd century AD.

Cat. No. 9 artifact was made with wire, engraving and granulation techniques. It is a hoop earring and has a pendant. The earring is single. One end of the thick wire is wrapped once to form a short-thick loop and the loop end is wrapped once around the body. The other end, tapering towards the attachment point, is wrapped once around the short hook loop. In the earring is the with rosette applique and wire pendant. A circular slot is opened on the outside of the hoop and small spheres are applied into it using the granulation technique. A long wire pendant was added to the earring by creating a large loop and there are small spheres made with the granulation technique at the end of the loop. The other end of the loop is knotted. There is a groove decoration made with the engraving technique on the wire attached to the earring. It similar examples are found in Tomb 36 in the Viminacium,[58] Tomb 67 in Pirivoj[59] and in the Istanbul Archaeological Museum.[60] It dates back to the 3rd century AD.

Cat. No. 11 artifact was made with wire and granulation techniques. It is a hoop earring and pendantless. The earring is pair. One end of the thick wire is wrapped once to form a short-thick ring, the other end, which tapers towards the connection point, is wrapped once and passed to the short hooked ring. A short wire is appliqued to the outside of the hoop. The spheres of various sizes were added to the ring using the granulation technique. The thin wire at the end of the spheres is undecorated and tapers towards the tip. A similar example is in the Istanbul Archaeological Museum and dates to the 4th century AD.[61]

Cat. No. 12 artifact was made with wire and sheet techniques. It is a hoop earring and has a pendant. The earring is single. One end of the thin wire is looped, the other end, which tapers towards the connection point, is wrapped once around a short hook hoop. It has a spherical-shaped pendant attached to a earring. It is possible to see similar examples in the Istanbul Archaeological Museum[62] and the British Museum.[63] It dates back to the Late Roman period.

[53] UYGUN 2000, 79, Pl.18, no. K4–5.
[54] OZGULNAR 2007, 106, K32.
[55] ERGIL1983, 40, no. 95.
[56] ADOLF 1975, 38, Pl. 49, no. 11–13.
[57] ROSENTHAL-HEGINBOTTOM 2018, 118, Fig. 48.
[58] GOLUBOVIC 2003 82, Pl. I, no. 8.
[59] MILOVANOVIC 2018, 123, no. 21.
[60] ERGIL 1983 43, no. 112.
[61] ERGIL 1983, 139.
[62] ERGIL 1983, 62, no. 62.
[63] MARSHALL 1911, 297, Pl. LIII, no. 2575.

Cat. No. 14 artifact was made in wire technique. It is a simple hoop earring and pendantless. It is without applique. The earring is single. One end of the thin wire is looped, and the loop end is wrapped twice around the body. The other end, tapering towards the attachment point, is wrapped once around the short hook hoop and twice around the hoop. There is a groove decoration on the body. The similar ones are found in Tomb 76 at Keszthely-Fenékpuszta[64] and in the tomb at Aquincum.[65] It dates back to the 3rd–4th century AD.

The technical workmanship and production techniques in the artifacts show that the art of jewellery was at an advanced level during the Roman Imperial period. The artfifacts with pendant and applique decorations are remarkable: the stylized grape cluster produced with granulation technique in Cat. No. 5; among the works produced with the casting technique; rosette decoration in Cat. No. 6, pyramid decoration in Cat. No. 7 and square applique and drop-shaped pendant earrings in Cat. No. 8; the earring with rosette applique and wire pendant, made with granulation technique, Cat. No. 9; the earring applique wire decoration and pendantless made with granulation and wire technique, Cat. No. 11; the made with wire and sheet technique, Cat. No. 12 has no applique decoration and has a spherical pendant. It is seen that the decorations in the works where granulation and casting techniques were used create an impressive image. It was determined from the decorations here that the soldering technique was also used. According to these artifacts, there are also simply produced artifacts such as Cat. No. 1–4 and 14. These artifacts were made with wire and engraving techniques. This situation can be explained by the fact that technological developments could not produce new forms despite the increasing demand for low-cost earrings and other jewellery.

Opened hoop earrings (Cat. No. 10)

Cat. No. 10 artifact is made with wire, plating and granulation techniques. It is a simple hoop earring and pendantless. It has a wire applique. This artifact is gold plated on bronze. Both ends taper towards the connection point. There is a thin wire applique placed by opening a hole in the middle of the hoop. Both ends of the applique is knotted. At the bottom of the applique there is a hoop form made of small spheres made with the granulation technique. A similar example is located in the Istanbul Archaeological Museum and dates back to the 4th century AD.[66]

Pendant (Cat. No. 13)

Cat. No. 13 artifact was made using plating, filigree and granulation techniques. It is a pendant. The hook or hoop part of this artifact has not been found. From the remains left inside the pendant, it was understood that it was designed as gold-plated on green matte glass. On one side of the pendant, there are small spheres made with the granulation technique, and on the other side, there are circular spiral decorations made with the filigree technique between the spiral hoops extending from top to bottom. It has been

[64] MULLER 2010, 278, Taf. 31, 76, 6/7.
[65] FACSÁDY 2008, 239, Fig. 1, no. 1b.
[66] ERGIL 1983, 139.

determined that geometric ornaments were successfully applied and a large amount of solder was used in this artifact, where granulation and filigree techniques were applied. Similar examples are in the Uşak-Kula,[67] British Museum,[68] J. J. Schmid-Ritter Collection[69] and in Tomb 107 in Memphis (Tennessee),[70] dating to the 1st–2nd century AD.

ANALYSIS STUDY

Materials and Methods

Of the artifacts examined in the study, 12 are gold, one is gold-plated on bronze, and one is gold-plated on glass.

Since it was not possible to take pieces from the artifacts or use destructive methods in the analysis of the artifacts, the analyses were carried out using non-destructive methods. 3 analysis methods were applied: Portable Energy Dispersive X–ray Fluorescence Spectrometry (P-EDXRF), X–ray Radiography, proton-source X–ray analysis μ-PIXE (Proton Induced X–ray Emission, μ-PIXE). Such micro-analytical techniques are widely used in ore characterization studies and provide very useful information with high accuracy and sensitivity. The numerical data in the analysis results were re-evaluated with the statistical analysis method SPSS.

The P-EDXRF method was chosen due to its features such as sensitivity to PPM in the non-destructive analysis of artifacts, ability to measure from the surface and determination of chemical components.[71] The analysis of the artifacts was performed with the X–MET 8000 Smart brand portable XRF. This device has a library of 1600 alloy standards and has a small compact design. The energy of the spectrometer is 40 eV. The analysis time was determined as 40–60 seconds. The alloys of the artifacts and images of these alloys were examined using X–ray radiography (Fig. 2). The instrumentation for such studies is very simple. In addition to the X–ray source, an object to detect the transmitted radiation and a material sensitive to X–rays; film are required.[72] Due to the different absorptions of X–ray radiation, it was possible to visualize the material distribution thanks to the different alloys used. Lower trace and few elements of the artifacts were tried to be determined by μ-PIXE method. Quantitative and visual outputs obtained during this examination constitute the micro-analytical data of the study. In this method, lower detection limits are obtained by using protons, which are heavier than electrons (Halden et al., 1995: 293–302).

Analysis Results

P-EDXRF method was used to determine the alloy and chemical components of the artifacts. Au (gold), Ag (silver), Cu (copper), Fe (iron), Cd (cadmium), Ti (titanium), Ni (nickel), Pb (lead), Si (silicon), Zn (zinc) and Sn (tin) elements were detected in the artifacts. The basic element is gold, and the common elements in the second group are copper and silver. The gold average of all artifacts is 90.7%, the copper average is 12.4% and the silver average is 1.4%. The few and trace elements are iron, cadmium, titanium, nickel, lead and silicon (Fig. 3).

Wire, filigree, casting, sheet, engraving, coating and granulation techniques were used in the studies (Fig. 4). The developments experienced during the processing of decorative ornaments made with granulation and filigree techniques include important analysis results. These two techniques (filigree and granulation techniques) are achieved by joining ornaments to a metal sheet using soldering techniques or copper salt.[73] Thanks to P-EDXRF, X–ray Radiography and μ-PIXE methods, the density and difference of the element used in melting and soldering in the works and the color change caused by this element are remarkable. The μ-PIXE analysis method was applied to determine the status of the solders used in the works subject to the study and the ratio of the alloys used. According to the analysis results, it was determined that the decorations were soldered using copper. Cat. No. 2, 0.8%; Cat. No. 3, 1.8%; Cat. No. 4, 3.6%; Cat. No. 5, 3.8%; Cat. No. 6, 3.2%; Cat. No. 7, 0.9%; Cat. No. 8, 1.2%; Cat. No. 9, 3.3%; Cat. No. 10, 1.3%; Cat. No. 11, 2.8%; Cat. No. 12, 1%; Cat. No. 13, 8.5%. The average copper ratio used in soldering is 2.6%.

All chemical compositions of the artifacts have been determined (Fig. 3). The main chemical composition is gold + silver + copper. This alloy is closely related to the archaeometric analysis results of gold jewellery from the Roman period.[74]

According to the analysis, especially when looking at the chemical components of the artifacts Cat. No. 1–9, 11–12, 14 it will be seen that the gold ratio is high. It is thought that the artifacts containing 97.5% (Cat. No. 12), 98.5% (Cat. No. 14), 98.6% (Cat. No. 1) gold are close to pure gold and are made from natural gold ore. The characteristics of the following examples as pure gold are closely related to the artifacts that are the subject of our study. Earrings from the Iron Age (Inv. No. K.53.32.93) and the Hellenistic period (Inv. No. K.247.19.73) in the Burdur Museum have the characteristics of pure gold.[75] It was determined that the 7th century BC earring (Inv. No. 15.35.75, gold ratio 97.2%) and the gold ring and earring from the Roman period (ring, Inv. No. 23.1.09, gold ratio 99.5%; earring, Inv. No. 10.30.97, gold ratio 99.1%) in the Diyarbakır Museum were made of pure gold, as in the examples above.[76] There are examples of works from the Hellenistic and Roman periods with an alloy ratio close to pure gold in the archaeological museums of Milas, Bodrum, Izmir, Çanakkale, Tekirdağ and Istanbul.[77] There are artifacts made of pure gold from the Roman period in the Taranto Museum in Italy.[78]

The silver and copper alloys were used as additives in Cat. No. 2–8, 10, 12–13. The copper alloys were not used as additives in Cat. No. 1 and 14. The silver average in these artifacts was 1.6% and the copper average was 4.9%. Considering that the artifacts are made of gold and have concave-convex forms, it is quite difficult to maintain the form

[67] BINGOL 1999, 83, cat. no. 67.
[68] MARSHALL 1911, 284, Pl. LII, no. 2412, 2417.
[69] STERN 1990, 148, Pl. 30, no. 696; 188, Pl. 72, no. 2900.
[70] ROSENTHAL-HEGINBOTTOM 2018, 108, Fig. 10.
[71] POTTS/WEST 2008, 55–56; LIRITZIS/ZACHARIAS 2011, 112–123.
[72] SCHREINER *et alii* 2004, 1–17; TROALEN *et alii* 2009, 111–119
[73] LILYQUIST 1993, 36–37; SCRIVANO *et alii* 2013, 251–255.
[74] BUCCOLIERI *et alii* 2017, 421–426.
[75] SOSLU/SOSLU 2024, 44, 47.
[76] GUNDEM/AYDIN 2021, 98.
[77] GUNDEM/AYDIN 2021, 99–100, fig. 8.
[78] BUCCOLIERI *et alii* 2017, 422.

created without alloys, as gold is a soft and easily workable substance. The silver and copper alloys are known to harden and strengthen the alloys to which they are added. In particular, the increase in silver in the alloy composition will cause the chemical reaction of the artifacts with the external environment to be higher, which will promote the surface enrichment process of gold.[79] The amount of silver and copper alloys in these artifacts is not enough to cause the color of the main alloy, namely gold, to change. However, the same is not true for Cat. No. 13. It has been documented that the color factor of different alloys can be well distinguished using X–ray radiography. The copper content of the artifact is 13.2%, which gives it a reddish color. Another reason for the color change in the artifact is the use of a mixture of 2.3% zinc and 4.1% tin. Using a similar analysis method, the same colours were detected in silver and copper alloy earrings (Inv. No. 12294A and Inv. No. 12294B) in the Taranto Museum.[80]

It has been determined that the most common soldering method is the copper diffusion joining method, and that this method is used very intensively in different and complex ornaments made with filigree and granulation techniques. While an increase in copper content is observed in the solid state diffusion bonding soldering area, an increase in gold content is observed in fusion welding.[81] This situation can be observed in soldering processes using copper. When soldering is performed, an increase in silver and copper content is determined in the joining areas. Solid state diffusion bonding shows an increase in copper content in the soldering area and an increase in gold content in the fusion weld. It is possible to see this situation in soldering processes using copper. In Cat. No. 2, a sphere was soldered using the granulation technique (Fig. 5a). Four small hoops were found heavily soldered in the hoop section of Cat. No. 4 (Fig. 5b). It was observed that the reddish colour was concentrated in the area where the decoration consisting of spheres made with the granulation technique was located on Cat. No. 5. Since the spheres were determined to be gold, it was determined that copper was used as solder to hold them together. It was determined that the artifact was broken and soldered in three separate places (Fig. 5c). It was observed that the spheres were soldered onto the rosette on the hoop of Cat. No. 9 using the granulation technique (Fig. 5d). In the pendant section of Cat. No. 10 (fig. 5e) and Cat. No. 11 (Fig. 5f), a decoration consisting of spheres was found to have been soldered using the granulation technique. The reddish color intensity in the decorations made with granulation and filigree techniques in Cat. No. 13 is remarkable. The copper and soldering process used in this artifact were effective in this color change (Fig. 5g). The gold has a lower melting point than copper. Therefore, soldering is done using an alloy that has a lower melting point than the alloy to be soldered.[82] The hard soldering technique was not used in soldering the spheres to each other. If this had been done, the spheres would have melted. This technique is more common in Egyptian jewellery. It was determined that the ancient earrings, identified as belonging to a child in Qurneh, melted due to overheating during soldering.[83] It is known that the beads found in the Wah tomb were made by hard soldering by adding copper to the base alloy.[84] There is also evidence that solder was used as a filler in some gold artifacts in the Campana collection.[85]

The few and trace elements were detected in Cat. No. 6–14. These are cadmium, titanium, nickel, silicon and iron. The low proportions of these elements may be due to the tools used during the mechanical cleaning of the artifact rather than the alloys used in its production, because the proportions of these elements are not sufficient to be due to the activities of the producer during the production phase. It is also possible that these elements originate from intercrystalline corrosion. Traces of iron oxide and calcium carbonate were also found in the analysis. It is thought that iron may be present only as an impurity or perhaps due to corrosion. The trace and few elements such as cadmium, nickel, silicon and iron were detected in the earring (Inv. No. K.247.19.73), ring (Inv. No. K.209.64.75, Inv. No. K.52.44.82, Inv. No. K.38.72.86) and bust (Inv. No. K.140.34.03) of the gold artifacts from the Hellenistic and Roman periods in Burdur Museum.[86] The iron and cadmium were also used as few and trace elements in the gold artifacts from the Roman period in the Diyarbakır Museum (Inv. No. 5.2.03, Inv. No. 10.30.97, Inv. No. 38.6.08, Inv. No. 21.9.84), and it was stated that these were formed as a result of mechanical cleaning.[87]

Cat. No. 13 is a pendant. Green matt glass residue was detected inside the pendant. The gold content is 75.9%, the silver content is 2.1% and the copper content is 13.2%. According to the analysis data, there is a 1.0 micron thick gold plating on the artifact. It was observed that the reddish color came to the fore due to the use of copper. In the examination made with the X–ray radiography method, it was seen that there were color changes around some decorations made with the granulation technique. This change is slight in some places and intense in others. Therefore, when the copper ratio is taken into account, it will be seen that the decorations are soldered onto the gold plating. According to μ-PIXE analysis, the copper ratio used in soldering is 13.2%. When the decorations on the artifact were examined, it was determined that careful soldering was done, because in this section the appearance of the soldering did not hinder the aesthetics of the artifact.

The alloys of tin and lead were used with copper in Cat. No. 10 and 13. This alloying mixture is an important feature of Roman and Byzantine bronze artifacts.[88] Cat. No. 10 is gold plated on bronze (Fig. 6). According to the analysis data, 0.9 micron thick gold plating was used in the study. It will be seen that the gold used as the coating alloy has lost its original color and has a matte color. The main reason for this is the mixture of copper, 3.8% zinc and 3.6% tin that forms the main body of the artifacts. Thanks to the X–ray radiography of the work, it was determined that the sections made with the granulation and coating technique were soldered using

[79] ARAÚJO/ LVES/CABRAI 1993, 450–453.
[80] BUCCOLIERI *et alii* 2017: 422–4233.
[81] DEMORTIER 1996, 347–353; SCRIVANO *et alii* 2013, 251–255.
[82] MARYON 1949, 95–96.
[83] TROALEN *et alii* 2009, 116, Fig. 4.
[84] SCHORSCH 1995, 128–133.
[85] GUERRA 2009, 484, Fig. 5.
[86] SOSLU/SOSLU 2024, 45, Fig. 2.
[87] GUNDEM/AYDIN 2021, 96–97, Fig. 4.
[88] FACSÁDY/VEREBES 2009, 993.

copper. The possibility of the artifact being recyclable is a question mark. Because the bronze earring was later covered with gold and used as an earring. The alloy amounts revealed in the analysis results of the artifact shed light on this issue. The copper ratio is 83.5% and the zinc ratio is 3.8%. The difference between copper and zinc is approximately 80%. The data here may be important for recycling scrap metals; cheaper alloys can be obtained by adding copper, and then these alloys can be used together with other alloys to produce artifacts. In other words, it can be said that it is a secondary production. When we look at the copper, zinc, tin and lead alloys in the artifacts, the copper ratio remains high and does not fall below 80%. However, the actual ratios of the alloy metals change. This can be shown as another evidence of recycling. The earrings (Inv. No: K.88.39.89) and rings (Inv. No: K.209.64.75, Inv. No: K.38.72.86) from the gold-plated bronze artifacts in Burdur Museum were made with a similar method.[89] The findings at the Aquincum Museum are an example of this. The copper-based jewellery pieces from Augsburg have a similar composition and are interpreted as having been produced from recycled scrap metal.[90] The lead is used for casting and joining complex shapes. This may apply to the granulation part of Cat. No. 13. Traces of transparent putty were found on Cat. No. 8. Although this material was initially thought to be the material used by the manufacturer, our examinations revealed that a putty-like solution prepared in Paraloid B–72 was used to clean the artifact. The Paraloid B–72 paste residue found to have been used during the mechanical cleaning of a bust (Inv. No: K.140.34.03) in the Burdur Museum can be given as an example of this.[91]

The statistical analysis of the alloys of the artifacts was performed using the SPSS method. Since the values of Au (gold), Ag (silver) and Cu (copper) alloys are high in this analysis, these 3 alloys will be mentioned in the data calculation. When the table is examined, it is seen that the Au variable spreads over a wide range between 51.600 and 98.600. The average is 90.664 and the standard deviation is 12.558, and it is seen that the data is generally close to the average, but significant deviations can be seen in some values. The variance is 157.712, which reflects the wide spread of the variable. The variable Ag is spread over a narrow range between 1000 and 3100. The mean is 1.414, which means that the observations are generally clustered around this value. The standard deviation is 0.585, which indicates that the values do not deviate too much from the mean. The variance of 0.343 also confirms this low deviation and shows that the variable has a relatively narrow spread. The Cu variable spreads in a fairly wide range between 0.000 and 83.500. The mean is 9.864, which shows that most of the observations are close to the low values. However, high values such as standard deviation 21.460 and variance 460.533 indicate that there are large deviations in the distribution of the variable and some observations reach very high values. Accordingly, when gold and copper data are examined, a negative change is observed in addition to gold and silver. It was observed that when the gold ratio was reduced, silver + copper alloys were used instead (Fig. 7).

CONCLUSION

Since all of the artifacts were not contextual finds but were registered in the museum inventory through purchase, dating was done on similar examples. According to these comparison examples, the approximate date range of the artifacts is between the 1st–4th centuries AD. during the Roman Imperial period. The technical workmanship and production techniques in the artifacts show that the art of jewellery was at an advanced level during the Roman Imperial period. For example, the sphere and grape cluster decorations created with the granulation technique, rosettes and pyramids created with the coating technique, spiral and circular geometric decorations made with the filigree technique and their flawless application are very important. The jewellery produced using soldering, filigree and granulation techniques are important evidence of this situation. However, there are also simply produced works such as Cat. No. 1 and 14. These artifacts were made with wire and engraving techniques. This phenomenon can be explained by the fact that technological advances have adapted to the increasing demand for low-cost earrings and other jewellery but have not been able to produce new forms. In addition, the socio-economic structure of ancient society, purchasing power and the products produced in this direction (demand-product quality) can also shed light on this issue. As mentioned above, since the artifacts entered the museum inventory through purchase, it is not possible to say anything definitive about their origins (places of production). However, it is possible to make some comments based on comparative examples. The fact that many similar forms of the artifacts numbered Cat. No. 2–4, which consist of hoop earrings pendantless made with wire and engraving technique, are found in Anatolia, has led to the idea that these artifacts may have been produced in Anatolia. Because it is known that gold was processed intensively and turned into various objects in Anatolia during the Roman Imperial period. Of course, it is also possible that the artifacts came to the Pisidia Region from outside Anatolia. In this case, it can be said that political, military and socio-economic developments have an important effect. Here, the existence of Mediterranean-Anatolia and Mediterranean-Pisidia relations constitutes important data. Although not found in the artifacts in question, the close similarity of the soldering workmanship (extreme heating-brazing-melting) in some gold artifacts in the Burdur Museum with the artifacts in Egypt suggests that they may have been found in the region due to the developments between the Mediterranean and Anatolia.

Using the P-EDXRF method, it was determined that the alloys of the Roman Imperial period artifacts were made of gold, silver and copper. Accordingly, when the chemical components of the Cat. No. 1–9, 11–12, 14 artifacts are examined, it will be seen that the gold ratio is high. It has been determined that the artifacts with 97.5% (Cat. No. 1), 98.5% (Cat. No. 14), 98.6% (Cat. No. 1) gold ratio are pure gold. In the tradition of gold jewellery making, when the gold ratio is reduced, silver + copper alloys are used instead of the

[89] SOSLU/SOSLU 2024, 46–47, 51–52, Tabl. 1, Fig. 9.
[90] FACSÁDY/VEREBES 2009, 993–998.
[91] SOSLU/SOSLU 2024, 51, Fig. 11.

lowered or diminished ones. In these examined artifacts, it was observed that the gold ratio in the alloys decreased and the silver and copper ratio increased. This situation was confirmed by SPSS statistical analysis method. Analyses using X–ray radiography documented that different alloys can be distinguished by color factor. The copper content of Cat. No. 5 is 6.9%, while the copper content of Cat. No. 13 is 13.2%. The use of copper here is due to technical workmanship and ornamentation. It was determined that the reddish color is evident in both artifacts due to the copper alloy. The copper alloy appears to have hardened and strengthened the artifacts. According to the X–ray radiography method, it was determined that the soldering process was quite intensive in the artifacts where copper alloy was widely used, but when the decorations on the artifacts were examined, it was determined that no damage occurred due to excessive melting during soldering. The fact that this situation does not occur even in works decorated with granulation and filigree techniques shows that the master has applied the techniques of gold jewellery making and assembling with mastery. It was determined that Cat. No. 14 was gold plated on bronze. The gold plated work has a matte color due to the bronze alloy. The fact that both the bronze and the coating are 0.9 microns thick plays an important role in this. This situation should also be examined in terms of ancient technology and its use. It is seen that the diversity in alloys is affected by historical chronology, type of object and use. As a result of the development of gold production technology and the skillful application of this technology, the range of available alloys has also expanded. The variety of alloys indicates that different technologies and skills coexisted during the production periods. This is reflected in the variety of ornaments on the artefacts and the alloys that allowed them to be soldered. In addition, this artifact was analyzed using X–ray radiography and is considered to be recycled jewellery, i.e. secondary production. The copper content of the artifact is 83.5%, lead content is 4.2%, zinc content is 3.8% and tin content is 3.6%. The difference between copper and zinc is approximately 80%. The average of zinc and tin alloys of the same artifact is 3.7%. The fact that the main alloy of the artifact is bronze proves that this alloy can be combined with different alloys to make jewellery. Because when we examine the copper, zinc, tin and lead alloys in the artifact, we see that the copper ratio remains high and does not fall below 80%. However, the ratios of the alloy metals are different and low. This can be shown as another evidence of recycling.

CATALOGUE

Cat. No.: 1 (Purchasing; 03.06.1974)
Inv. No.: K.204.14.74
Dimension: L: 1.8 cm W: 1.8 cm T: 0.2 cm W: 1.25 gr
Technique: Wire.
Similar: TURKTUZUN 1990, 44, Fig. 7; YUCE 1994, Fig. 9, 93/3; MILOVANOVIC 2003, 134, Pl. 2, IIa; ARSLAN *et alii* 2011, 287, 291, Fig. 3; TALU 2020, 162, 165, cat. no. 4, 6; SIRIN/YIGITPASA 2021, 209, Fig. 32, cat. no. 32; KAYA *et alii* 2024, 185, Fig. 5a-b.
Description: Gold. Sturdy. Hoop earring and pendantless. One end of the wire is wrapped twice around the itself, forming a large double loop. It wraps twice over the short hook loop at the other end, tapering towards the attachment point. The wire is wrapped four times to form a spiral ornament.
Period: 2nd–4th century AD

Cat. No.: 2 (Purchasing; 23.08.1988)
Inv. No.: K.13.28.88
Dimension: L: 1.5 cm W: 1.4 cm T: 0.2 cm W: 1 gr
Technique: Wire, engraving.
Similar: MARSHALL 1911, Pl. LIII, no. 2464; ADOLF 1975, 62, Pl. 49, no. 10; BINGOL 1999, 71, cat. no. 46; UYGUN 2000, Pl. 23, K11; OZGULNAR 2007, 76, cat. no. 2; ERTEN 2018, 15, Fig. 5; GORAL 2019, 127, cat. no. 11; ATAKURU 2020, 56, cat. no. 3; SIMSEK 2022, 674, 677–678, cat. no. 267–268, 274–275.
Description: Gold. Sturdy. Hoop earring and pendantless. One end of the thick wire is wrapped twice around itself to form a small double loop and the loop end is wrapped six times around the body; the other end, tapering towards the connection point, is wrapped once around the long hook loop. One small hoop on the body; grooved decoration, short scratches on the surface.
Period: 1st–3rd century AD

Cat. No.: 3 (Purchasing; 05.12.1975)
Inv. No.: K.18.12.75
Dimension: L: 2.3 – 2.1 cm W: 1.9 – 1.8 cm T: 0.2 cm W: 5.75 gr
Technique: Wire, engraving.
Similar: MARSHALL 1911, Pl. LIII, no. 2464; ADOLF 1975, 62, Pl. 49, no. 10; BINGOL 1999, 71, cat. no. 46; UYGUN 2000, Pl. 23, K11; OZGULNAR 2007, 76, cat. no. 2; ERTEN 2018, 15, Fig. 5; GORAL 2019, 127, cat. no. 11; ATAKURU 2020, 56, cat. no. 3; SIMSEK 2022, 674, 677–678, cat. no. 267–268, 274–275.
Description: Gold. Sturdy. Hoop earring and pendantless. One end of the thick wire is wrapped twice around itself to form a small double loop and the loop end is wrapped seven times around the body; the other end, tapering towards the connection point, is wrapped once around the long hook loop. The body has groove decoration.
Period: 1st–3rd century AD

Cat. No.: 4 (Purchasing; 05.05.2012)
Inv. No.: K.111.17.12
Dimension: L: 1.8 cm W: 1.7 cm T: 0.3 cm W: 1.56 gr
Technique: Wire, engraving.
Similar: MARSHALL 1911, Pl. LIII, no. 2464; ADOLF 1975, 62, Pl. 49, no. 10; BINGOL 1999, 71, cat. no. 46; UYGUN 2000, Pl. 23, K11; OZGULNAR 2007, 76, cat. no. 2; ERTEN 2018, 15, Fig. 5; GORAL 2019, 127, cat. no. 11; ATAKURU 2020, 56, cat. no. 3; SIMSEK 2022, 674, 677–678, cat. no. 267–268, 274–275.
Description: Gold. Sturdy. Hoop earring and pendantless. One end of the thick wire is wrapped around itself twice to form a small double loop. The other end, tapering towards the attachment point, is wrapped once over the long hook loop. A spiral decoration was made on the body by wrapping

the wire five times. There are two small hoops on the body. There are groove decorations on the earring.
Period: 1st–3rd century AD

Cat. No.: 5 (Purchasing; 18.05.1977)
Inv. No.: K.78.38.77
Dimension: L: 1.8 cm W: 1.9 cm T: 0.3 cm
Technique: Wire, granulation.
Similar: MARSHALL 1911, Pl. LIV, no. 2596; HOFFMAN/DAVIDSON 1965, 134. no. 87; GREINFENHAGEN 1975, Pl. 48/7; BALTOYIANNI 1997, 177, cat. no. 189; BINGOL 1999, 69, cat. no. 42; MULLER 2010, 296, Taf. 49–12; SEZGIN 2014, 89, no. 82; UNGERMAN 2020, 285, Fig. 182.1.
Description: Gold. Lacking. Hoop earring and pendantless. Both ends of the thick wire are of equal thickness towards the connection point. The outer side of the earring is decorated with small spheres made in the granulation technique; two of the grape cluster decorations are intact, the other two are missing.
Period: 2nd century AD

Cat. No.: 6 (Purchasing; 18.05.1977)
Inv. No.: K.72.38.77
Dimension: L: 1.7–1.5 cm W: 1.5 cm T: 0.1 cm R. R: 1.2 cm
Technique: Casting, wire.
Similar: MILOVANOVIC 2018, 119, no. 16.
Description: Gold. Lacking. Hoop earring and pendantless. One end of the thick wire is wrapped once around itself to form a single loop, and the loop end is wrapped twice around the itself; the other end, tapering towards the connection point, is wrapped twice around the short hook loop. The base of the earring is flat and the upper profile is convex; there are a rosette ornament made with the casting technique. There are two strips at the base that intersect each other at right angles.
Period: 2nd century AD

Cat. No.: 7 (Purchasing; 16.02.1977)
Inv. No.: K.27.23.77
Dimension: L: 1.9–1.7 cm W: 1.7- 1.5 cm T: 0.2 cm
Technique: Casting, wire.
Similar: MARSHALL 1911, Pl. LII, no. 2394, 2396; GREINFENHAGEN 1975, Pl. 49/9; TURKTUZUN 1991, 244, Fig. 25; BINGOL 1999, 74, cat. no. 52; UYGUN 2000, Pl. 25, no. K16; FACSÁDY 2008, Fig. 1, no. IVb; MILOVANOVIC 2018, 123, Fig. 22; GORAL 2019, 145, no. 36.
Description: Gold. Sturdy. Hoop earring and pendantless. One end of the thin wire is wrapped once around itself to form a short loop. The other end, tapering towards the connection point, is wrapped once over the short hook loop. The wire is wrapped twice to create a spiral decoration on the body. A flat-based pyramid is soldered to the outer surface of the hoop.
Period: 2nd–3rd century AD

Cat. No.: 8 (Purchasing; 27.06.1973)
Inv. No.: K.609.50.73
Dimension: L: 1.4 cm W: 1 cm T: 0.1 cm PL: 2 cm PW: 0.7 cm PT: 0.4 cm
Technique: Casting, wire, plating.
Similar: ADOLF 1975: pl. 49, no. 11–13; ERGIL 1983: 40, no. 95; UYGUN 2000: Pl. 18, no. K4–5; OZGULNAR 2007: 106, K32; ROSENTHAL-HEGINBOTTOM 2018: 118, Fig. 48.
Description: Gold. Sturdy. Hoop earring and pendant. One end of the wire is wrapped around itself once to form a short loop. The other end, tapering towards the connection point, is wrapped once around the short hook hoop. A square-shaped and flat-based applique is soldered to the outer surface of the body.
Period: 2nd century AD

Cat. No.: 9 (Purchasing; 18.05.1977)
Inv. No.: K.81.38.77
Dimension: L: 1.3 cm W: 1.4 cm T: 0.1 cm PL: 1.1 cm PW: 0.1 cm PT: 0.1 cm
Technique: Wire, engraving, granulation.
Similar: ERGIL 1983, 43, no. 112; GOLUBOVIC 2003, 82, Pl. I, no. 8; MILOVANOVIC 2018, 123, no. 21.
Description: Gold. Sturdy. Hoop earring and pendant. One end of the thick wire is wrapped once around itself to create a short-thick loop. The other end, which tapers towards the connection point, is wrapped once around the short hook loop. A circular slot is created on the outside of the loop. Beads are placed inside the slot in the granulation technique. A loop is created in the body and a long wire pendant is added to the end. At the end of the loop is a bead made in the granulation technique. The other end is knotted. There are groove decorations made with the engraving technique on the wire pendant.
Period: 3rd century AD

Cat. No.: 10 (Purchasing; 26.11.1969)
Inv. No.: E.8339
Dimension: L: 2.7 cm W: 2 cm T: 0.3 cm
Technique: Wire, plating, granulation.
Similar: ERGIL 1983, 139.
Description: Gold, bronze. Sturdy. Hoop earring and pendantless. It tapers towards the connection point at both ends. A thin wire pendant is placed in the middle part of the hoop. Both ends of the pendant are knotted. At the bottom of the pendant, there is a hoop form made of spheres made with the granulation technique.
Period: 4th century AD

Cat. No.: 11 (Purchasing; 27.06.1973)
Inv. No.: K.611.50.73
Dimension: L: 1.3 cm W:1.6 cm T: 0.2 cm PL: 0.9 cm PW: 0.6 cm PT: 0.3 cm
Technique: Wire, granulation.
Similar: ERGIL 1983, 139.
Description: Gold. Sturdy. Hoop earring and pendantless. One end of the thick wire is wrapped once around itself to form a short-thick loop. The other end, which tapers towards the connection point, is wrapped once over the short hook loop. The short wire soldered to the outside of the middle section of the loop. There are large and small spheres placed with the granulation technique where the hoop and applique meet. There is no decoration on the wire applique, which tapers towards the end.

Period: 4th century AD

Cat. No.: 12 (Purchasing; 09.04.1985)
Inv. No.: K.6.12.85
Dimension: L: 1 cm W: 1.5 cm T: 0.1 PL: 1.7 cm PW: 0.7 cm PT: 0.3 cm
Technique: Wire, sheet.
Similar: MARSHALL 1911, Pl. LIII, no. 2575; ERGIL 1983, 62, no. 62.
Description: Gold. Sturdy. Hoop earring and pendant. There is a loop at one end of the wire. The other end, tapering towards the attachment point, is wrapped once around the short hook loop. Inside the loop is a spherical pendant with a thick loop; the end is knotted.
Period: Late Roman period

Cat. No.: 13 (Purchasing; 08.02.2010)
Inv. No.: K.94.9.10
Dimension: L: 1.3 cm W: 0.8 cm T: 0.3 cm
Technique: Plating, filigree, granulation.
Similar: MARSHALL 1911, Pl. LII, no. 2412, 2417; GREINFENHAGEN 1970, Pl. 24/3–4; STERN 1990, Pl. 30, 72, no. 696, 2900; BINGOL 1999, 83 cat. no. 67; ROSENTHAL-HEGINBOTTOM 2018, 108, Fig. 10.
Description: Gold, glass. Lacking. Pendant. Thin gold plate coating on glass. On one side of the pendant are small spheres made with the granulation technique; On the other side, there are circular spiral decorations made with filigree technique.
Period: 1st–2nd century AD

Cat. No.: 14 (Purchasing; 30.04.1971)
Inv. No.: E.9591
Dimension: L: 5.1 cm W: 4.6 cm T: 0.3 cm W: 7.70 gr
Technique: Wire.
Similar: FACSÁDY 2008, 239, Fig. 1, no. 1b; MULLER 2010, 278, Taf. 31, 76, 6–7.
Description: Gold. Sturdy. Hoop earring and pendantless. The end of the thin wire is wrapped around itself to form a loop. The other end, tapering towards the connection point, is wrapped once over the short hook loop. A spiral decoration was made on the body by wrapping the wire twice. The body is grooved decorated.
Period: 3rd–4th century AD

REFERENCES

ADOLF 1975
Adolf, G. *Schmuckarbeiten in Edelmetall II* (Berlin: Einzelstücke).

ARAÚJO/ALVES/CABRAI 1993
Araújo, M. F./Alves, L. C./Cabrai, J. M. P., Comparison of EDXRF and PIXE in the analysis of ancient gold coins, *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms* 75, 1–4, 450–453.

ARSLAN *et alii* 2011
Arslan, M./Metin, M./Cinemre, O./Çelik, T./Devecioğlu, Ü. Juliopolis Nekropolü 2009 Yılı Kurtarma Kazısı, *Müze Çalışmaları ve Kurtarma Kazıları Sempozyumu* 19, 271–304.

ATAKURU 2020
Atakuru, Ö. *Adana Arkeoloji Müzesi Roma-Bizans Altın Takıları* (Master's diss., Gazi University).

BALTOYIANNI 1997
Baltoyianni, Ch., Byzantine Jewellery. In: Kypraiou, E. (eds.), *Greek Jewellery. 6,000 Years of Tradition. (Exhibition) Thessaloniki, Villa Bianca*, (Athens: Archaeological Receipts Fund), 151–247.

BINGOL 1999
Bingöl, I. F. R., *Anadolu Medeniyetleri Müzesi, Antik Takılar* (Ankara: T.C. Kültür Bakanlığı Anıtlar ve Müzeler Genel Müdürlüğü).

BOLLÓK 2010
Bollók, Á. Byzantine Jewellery of the Hungarian Conquest Period: a View from the Balkans. In: Entwistle, C./Adams, N. (eds.), *Intelligible Beauty. Recent Research on Byzantine Jewellery*, 173–185.

BUCCOLIERI *et alii* 2017
Buccolieri, A./Castellano A./Degl'innocenti, E. R./Cesareo, R./Casciaro, R./Buccolieri, G. EDXRF analysis of gold jewellery from the Archaeological Museum of Taranto, Italy, *X-Ray Spectrom* 46, 421–426.

DEMORTIER 1996
Demortier, G., Ion beam studies of archaeological gold jewellery items, *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms* 113, 347–353.

DUCHENE 1983
Duchene, H., *Troia Hazineleri veya Schliemann'ın Düşü* (İstanbul: Yapı Kredi Yayınları).

ERGIL 1983
Ergil, T., *Küpeler İstanbul Arkeoloji Müzeleri Küpeler Kataloğu* (İstanbul: Güzel Sanatlar Matbaası).

ERTEN 2018
Erten, E. *Silifke Müzesi Cam Kataloğu* (Ankara: Bilgin Kültür Sanat Yayınları).

FACSÁDY 2008
Facsády, A. R., Earings on Stone Monuments from Pannonia. In: Franek, C./Lamm, S./Neuhauser, T./Porod, B./Zöhrer, K., *THIASOS Festschrift für Erwin Pochmarski zum 65. Geburtstag*, (Wien: Phoibos), 229–242.

FACSÁDY/VEREBY 2009
Facsády, A. R./Vereby, A., Analysis of Roman Bronze Finger Rings from Aquincum, *Materials and Manufacturing Processes* 24, 993–998.

GERMANA 2019
Germana, G., Le arti suntuarie e la pittura nella Sicilia bizantina. In: Bisconti, F./Braconi, M./Sgarlata, M., *Arti minori e arti maggiori. Relazioni e interazioni tra Tarda Antichità e Alto Medioevo*, (Todi: Perugia), 1–17.

GOLUBOVIC 2003
Golubovic, S., Jewellery and the Costume Decorations in the Cremation Graves from Viminacium, *Anados Studies of the Ancient World* 3, 70–90.

GORAL 2019
Goral, S., *Tokat Müzesi'nde Yunan ve Roma Dönemi Altın Takıları* (Master's diss., Atatürk University).

GREIFENHAGEN 1970
Greifenhagen, A., *Schmuckarbeiten in Edelmetall I* (Berlin: Fundgruppen).

GREIFENHAGEN 1975
Greifenhagen, A., *Schmuckarbeiten in Edelmetall II* (Berlin: Einzelstücke).

GUERRA 2009
Guerra, M. F., Etruscan gold jewellery: genuine, restored or pastiche?, *Metales* VII CIA – S3, 479–489.

GUNDEM/AYDIN 2021
Gündem, E./Aydın. M., Archaeometric Characterization of A

Group of Gold Jewellery from the Diyarbakır Archaeological Museum, *Türkiye Bilimler Akademisi Arkeoloji Dergisi* 24, 93–103.

HALDEN/CAMPBELL/TEESDALE 1995
Halden, N. M./Campbell, J. L./Teesdale. W., PIXE Analysis in Mineralogy and Geochemistry, *The Canadian Mineralogist* 33, 293–302.

HOFFMANN/DAVIDSON 1965
Hoffmann, H./Davidson, F., *Greek Gold: Jewellery from the Age of Alexander* (Boston: Brooklyn and Richmond).

JULIIS 1984
Juliis, E., *Gli Ori Di Taranto in Eta Ellenistica* (Milano: Arnoldo Mondadori).

KALAMARA 2013
Kalamara, P., Clothing and Personal Adornment: The Semantics of Attire. In: Drandaki, A./Papanikola-Bakirtzi, D./Tourta, A. (eds.), *Heaven & Earth Art of Bizantium From Greek Collections* (Athens: Hellenic Ministry of Culture and Sports and the Benaki Museum), 223–278.

KAYA *et alii* 2024
Kaya, F. H./Albayrak, M./Henig, M./Laflı, E., Earrings from Nicaea in Bithynia (south-eastern Marmara), *Cercetări Arheologice* 31, 1, 179–204.

KRAUß *et alii* 2017
Krauß, R./Schmid, C./Kirschenheuter, D./Abele, J./Slavchev, V./Weninger, B., Chronology and Development of the Chalcolithic Necropolis of Varna, *Documenta Praehistorica* 44, 282–305.

LANGO 2010
Lango, P., Crescent-Shaped Earrıngs With Lower Ornamental. In: Daim, F./Drauschke, J. (eds.), *Byzanz-das Römerreich im Mittelalter Teil 3 Peripherie und Nachbarschaft* (Mainz: Verlag des Römisch-Germanischen Zentralmuseums), 360–410.

LILYQUIST 1993
Lilyquist, C., Granulation and Glass: Chronological and Stylistic Investigations at Selected Sites, ca. 2500–1400 B.C.E., *Bulletin of the American Schools of Oriental Research* 290–291, 29–94.

LIRITZIS/ZACHARIAS 2011
Liritzis, I./Zacharias, N., Portable XRF of Archaeological Artifacts: Current Research, Potentials and Limitation's. In: Shackley, M. S. (ed.), *X–Ray Fluorescence Spectrometry (XRF) in Geoarchaeology* (New York, London: Springer), 109–142.

MARSHALL 1911
Marshall, F. H., *Jewellery Greek, Etruscan and Roman in the Departments of Antiquities British Museum* (London: Printed by order of the Trustees).

MARYON 1949
Maryon, H., Metal Working in the Ancient World, *American Journal of Archaeology* 53, 2, 93–125.

MILOVANOVIC 2003
Milovanovic, B., Earings-Symbol of Femininity of Roman Ladies of Viminacium, *Anodos, Studies of the Ancient World* 3, 131–143.

MILOVANOVIC 2018
Milovanovic, B., Jewellery as a Symbol of Prestige, Power and Wealth of the Citizens of Viminacium. In: Golubovic, S. (ed.), *VIVERE MILITARE EST From Populus to Emperors Living on the Frontier*, Vol. II (Belgrade: Institute of Archaeology), 101–141.

MULLER 2010
Muller, R. *Die Gräberfelder vor der Südm auer der Befestigung von Keszthely-Fenékpuszta* (Budapest, Leipzig, Keszthely: Alle Rechte vorbehalten).

OZGULNAR 2007
Özgülnar, N. *Perge Kazılarında Bulunmuş Takılar* (Master's diss., Istanbul University).

PAPAGEORGIY 2003
Papageorgiy, E., Χρυσό ενώτιο της Πρώιμης Εποχής του Χαλκού στις συλλογές του Μουσείου Μπενάκη [A Gold Earring of the Early Bronze Age from the Collections of the Benakis Museum]. In: Vlachopoulos, A./ Birtacha, K., *Αργοναύτης: τιμητικός τόμος για τον καθηγητή Χρίστο Γ. Ντούμα [Argonautes. Studies Presented to Professor Christos Doumas]* (Athena), 211–224.

POSSENTI 2019
Possenti, E. Una valva da fusione di età altomedievale dal territorio altinate, *Antichistica* 23, 273–297.

POTTS/WEST 2008
Potts, P. J./West, M., *Portable X–Ray Fluorescence Spectrometry Capabilities for in Situ Analysis* (Cambridge: RSC).

ROSENTHAL-HEGINBOTTOM 2018
Rosenthal-heginbottom, R., Schmuck aus dem Reich der Nabatäer Hellenistische Traditionen in frührömischer Zeit. In: Rosenthal-Heginbottom, R./Kögler, P. (eds.), *Journal of Hellenistic Pottery and Material Culture III* (Oxford: Archaeopress), 88–179.

SCRIVANO *et alii* 2013
Scrivano, S./Gómez-tubío, B./Ortega-feliu, I./Ager, F. J./Moreno-suárez, A. I./Respaldiza, M. A./De La Bandera, M. L./Marmolejo, A., Identification of soldering and welding processes in ancient gold jewellery, *X–Ray Spectrom* 42, 251–255.

SCHORSCH 1995
Schorsch, D., The gold and silver necklaces of Wah: a technical study of an unusual metallurgical joining method. In: Brown, C./Macalister, F./Wright, M. (eds.), *Conservation in Ancient Egyptian Collections* (London: Archetype Publications), 127–135.

SCHREINER *et alii* 2004
Schreiner, M./Fruhmann, B./Jembrih-Simburger, D./Linke, R., X–Rays in Art and Archaeology: An overview, *International Centre for Diffraction Data* 47, 1–17.

SCHULZE-DORRLAMM 2020
Schulze-dorrlamm, M., Alter Und Funktion Der Goldschmiedearbeiten." In: Schulze-dorrlamm, M. (ed.), *Vor- und Frühgeschichtlicher Altertümer Band 42, Byzantinische Goldschmiedearbeıten Im Römisch-Germanischen Zentralmuseum*, (Mainz: Verlag des Römisch-Germanischen Zentralmuseums), 7–39.

SEZGIN 2014
Sezgin, N., *Anadolu Medeniyetleri Müzesi'ndeki Metal Takılar* (Master's diss., Atatürk University).

SOSLU/SOSLU 2024
Soslu, S./Soslu, A. Archeometric Analysis af a Group af Gold Artifacts in Burdur Museum (Türkiye), *Scientific Culture* 10, 3, 39–55.

SRIBAR/STARE 1974
Sribar, V./Stare, V. Od kod ketlaske najdbe v Furlaniji?, *Arheoloski Vestnik* 25, 462–482.

STERN 1990
Stern, W. B., Zerstörungsfreie Analysen des Edelmetallschmucks. In: Stern, W. B./Beck, C. W./Furger, A. (eds.), *Der Römische Schmuck aus Augst und Kaiseraugst, Amt für Museen und Archäologie des Kantons Basel-Landschaft* (Herausgeber), 18–49.

SIMSEK 2022
Şimşek, M., *Kibyra Doğu Nekropolisi Claudii ve Flavii Aileleri Mezarlığı* (Ph.D. diss., Akdeniz University).

SIRIN/YIGITPASA 2021
Şirin O. A./Yiğitpaşa, D., Yeni Veriler Işığında Amisos Altın Eserleri Üzerine Gözlemler, *Amasya Üniversitesi Sosyal Bilimler Dergisi* 10, 143–216.

TALU 2020
Talu, S., *Myra ve Andriake'de Ele Geçen Takılar* (Master's diss., Akdeniz University).

TROALEN *et alii* 2009
Troalen, L. G./Guerra, M. F./Tate, J./Manley, B., Technological

study of gold jewellery pieces dating from the Middle Kingdom to the New Kingdom in Egypt. ArcheoSciences, *Revue d'archéométrie* 33, 111–119.

TURKTUZUN 1990
Türktüzün, M., Bölcek Köyü Nekropolü Kurtarma Kazısı, *Müze Kurtarma Kazıları Semineri* 1, 41–47.

TURKTUZUN 1991
Türktüzün, M., Roma Devri Nekropolü Kurtarma Kazısı, *Türk Arkeoloji Dergisi* 49, 225–249.

UNGERMA 2020
Ungermna, Š., Earrings as Typical Representants of the International. In: Poláček, L. (ed.), *Fashion, Great Moravian Elites From Mikulčice* (Brno: Academy of Sciences, Institute of Archaeology), 273–464.

UYGUN 2000
Uygun, C., *Patara Geç Helenistik-Roma Dönemi Takıları* (Master's diss., Akdeniz University).

UYGUN 2021
Uygun, C., Kadın ve Takı: Antik Dönem Kuyumculuğuna Genel Bir Bakış. In: Özkaya, O./Eraslan, A. (eds.), *Kadın Dünyası Üzerine Araştırmalar (Tarih, Göç, Ekopolitik, Hukuk ve Edebiyat)* (Ankara: Gazi Kitabevi), 191–235.

WILLIAMS/OGDEN 1994
Williams, D./Ogden, J. *Greek Gold Jewllery of the Classcal World* (London: Published for the Trustees of the British Museum by British Museum Press).

YUCE 1994
Yüce, A., Amasya Merkez Eski Şamlar Mezarlığı 1993 Yılı Kurtarma Kazısı, *Müze Kurtarma Kazıları Semineri* 5, 1–16.

ZIMMERMANN 2016
Zimmermann, T., Ancient Jewellry in Turkey. In: Selin, H. (ed.), *Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures* (New York: Springer), 1–15.

Fig. 1. Burdur Museum gold earrings.

Fig. 2. X–ray Radiography appearance.

Cat. No.	Inv. No.	Au	Ag	Cu	Fe	Cd	Ti	Ni	Pb	Si	Zn	Sn	Notes
1	K.204.14.74 1	98,6	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	
2	K.13.28.88 2	93,3	1,5	6,1	ND	ND	ND	ND	ND	ND	ND	ND	
3	K.18.12.75 3	94,2	1,8	4	ND	ND	ND	ND	ND	ND	ND	ND	
4	K.111.17.12 4	95,2	1,2	3,6	ND	ND	ND	ND	ND	ND	ND	ND	
5	K.78.38.77 5	90,2	3,1	6,9	ND	ND	ND	ND	ND	ND	ND	ND	
6	K.72.38.77 6	94,3	1,1	5,5	ND	ND	ND	0,2	ND	0,4	ND	ND	
7	K.27.23.77 7	96,3	1,2	2,5	0,7	ND	ND	ND	ND	ND	ND	ND	
8	K.609.50.73 8	96,1	1	2,2	0,3	0,6	ND	ND	ND	ND	ND	ND	
9	K.81.38.77 9	93,2	1,1	5,3	0,4	ND	ND	ND	ND	ND	ND	ND	
10	K.8339 10	51,6	1,4	83,5	0,5	ND	0,3	ND	4,2	ND	3,8	3,6	Bronze and gold
11	K.611.50.73 11	94,4	1,3	4,3	0,5	ND	ND	ND	ND	ND	ND	ND	
12	K.6.12.85 12	97,5	1	1	ND	ND	0,5	ND	ND	ND	ND	ND	
13	K.94.9.10 13	75,9	2,1	13,2	0,3	ND	ND	ND	2,1	ND	2,3	4,1	Green matte glass and gold
14	E.9591 14	98,5	1	ND	0,5	ND	ND	ND	ND	ND	ND	ND	

Fig. 3. P-EDXRF analysis data of the artifacts.

Fig. 4. Production techniques.

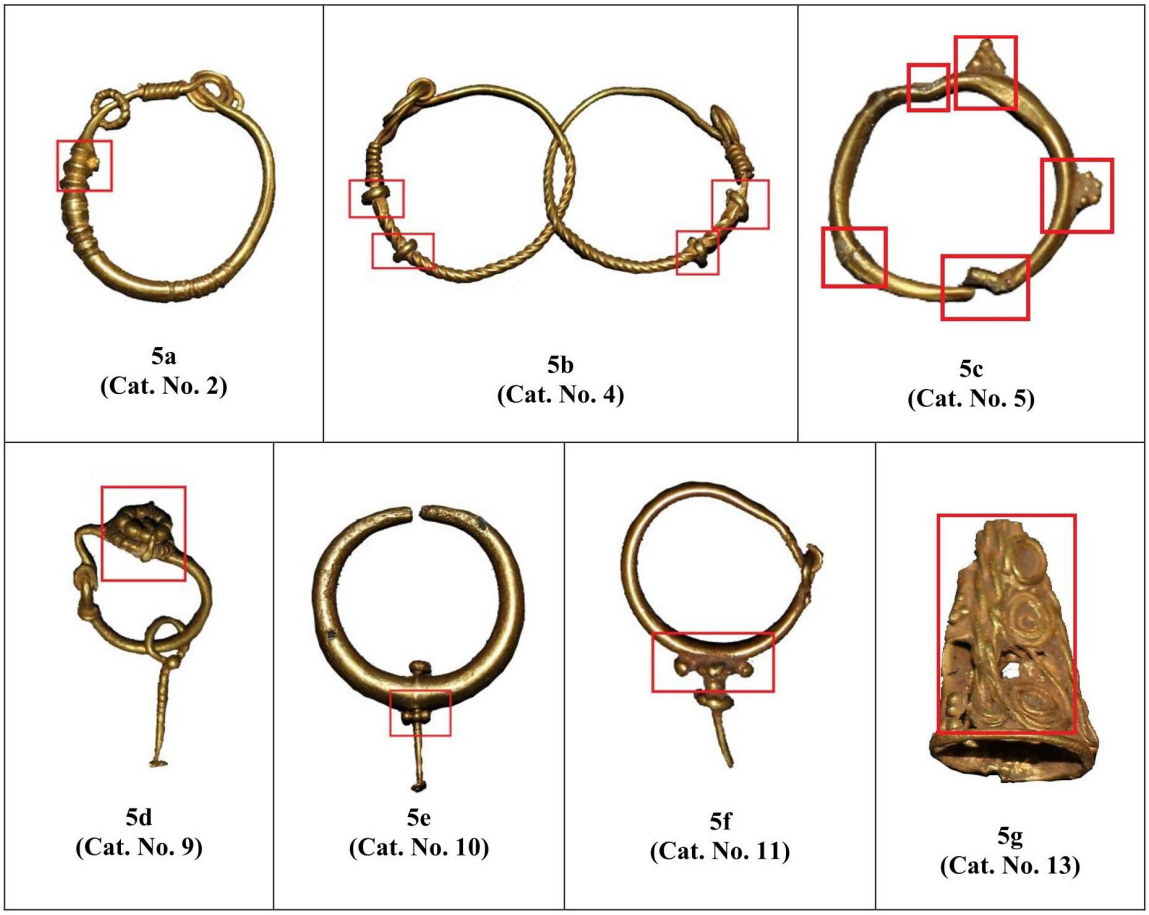

Fig. 5. The color change and solder mark obtained by μ-PIXE analysis and X–ray Radiography appearance.

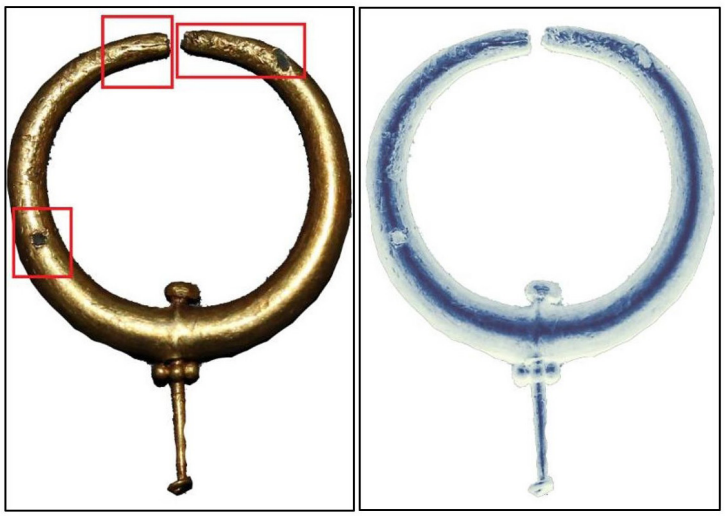

Fig. 6. Cat. No. 10 gold plating on bronze and X–ray Radiography appearance.

Research Method	Au	Ag	Cu	Fe	Cd	Ti	Ni	Pb	Si	Zn	Sn
Minimum	51,600	1,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Maximum	98,600	3,100	83,500	0,700	0,600	0,500	0,200	4,200	0,400	3,800	4,100
Mean	90,664	1,414	9,864	0,092	0,042	0,057	0,014	0,450	0,028	0,435	0,550
Standard Deviation	12,558	0,585	21,460	0,205	0,160	0,150	0,053	1,215	0,106	1,145	1,401
Variance	157,712	0,343	460,533	0,042	0,026	0,023	0,003	1,478	0,011	1,313	1,964

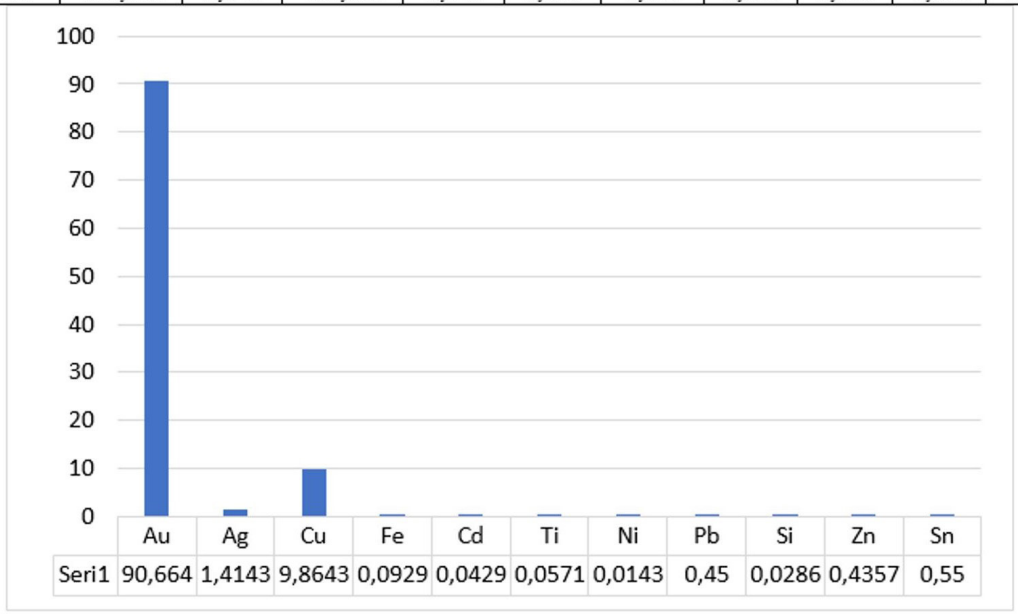

Fig. 7. Descriptive statistics of variables and graphical representation of mean value distributions.