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Retention of Zn, Cu, Cd, Pb, and As on human bones unearthed at a Central Anatolian Early Bronze Age excavation site (Resuloğlu, Turkey)

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Abstract
The retention of zinc (Zn), copper (Cu), cadmium (Cd), lead (Pb), and arsenic (As) on rib bones belonging to 81 individuals gathered from the Resuloğlu necropolis, a Central Anatolian Early Bronze Age (EBA) excavation site, were analyzed. Graphite Atomic Absorption Spectrometry (GFAAS) was used for the assays of Pb and Cd. Furthermore, Cu and Zn were evaluated with Fast Sequential Atomic Absorption Spectrometry (FSAAS) while As was analyzed using the hydride system. The ranges of Zn, Cu, Cd, Pb, and As levels were found between 103.96- 837.34 ppm; 1.99-396.46 ppm; 0.13-2.95 ppm; 0.87-34.89 ppm; 0.35-36.43 ppm, respectively. The outcomes vary highly among age groups. In order to reveal the origin of the retentions, soil and water samples obtained from the different regions of the excavation area were also analyzed. Both bone/soil ratios for each element and proximity to the Resuloğlu region, in which rich Cu, Pb, Zn, Fe and Mn ore deposits can be found, support the notion that the origin of the accumulations arises from diagenetic effects. Yet, no influence of metal concentrations was found in water samples over the bones. For Cu retention, especially on bones, it is believed that the major factor behind the accumulation depends not only on diagenetic factors but also burial gifts.

Keywords: *Chemical anthropology, bioarchaeology, Early Bronze Age (EBA), human bones, diagenetic factors*

Introduction

Chemical studies on archaeological human bones have a complementary role along with their morphological and genetic oriented counterparts in learning more about both ways of life and human interaction with the environment in specific archaeological community. In this context, the accumulation of some toxic metals such as lead, arsenic and cadmium in bone tissues reflects environmental conditions and pollution.

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On the other hand, some trace elements such as copper and zinc are more related with diet (Farnum et al., 1995; Jurkiewicz et al., 2004).

Many studies using analysis of toxic metals and trace elements have been carried out to reveal more about the background of past communities. Glen-Haduch et al. (1997) tested hypotheses corresponding to the relation between element concentrations and bone pathologies such as *cribra orbitalia* and *porotic hyperostosis* in Neolithic and Early Bronze Age (EBA) skeletons by measuring the levels of these elements using Atomic Absorption Spectrometry (AAS). González-Reimers et al. (2001; 2003) investigated the levels of lead, copper and cadmium in bones belonging to inhabitants and domestic animals of Grand Canaria in order to discern the origin of exposure to these metals. Grattan et al. (2002; 2005) and Pyatt et al. (2005) studied environmental pollution connected with the accumulation of copper and lead in human skeletal remains of individuals who lived or worked in the Roman copper mines of Phaeno in Wadi Faynan, southwestern Jordan. Other potential sources of toxic metals found in archaeological human bones are metal artifacts such as tools, weapons, and jewelry which are mainly composed of arsenical copper alloy or bronze as well as the diagenetic factor of soil (Martínez-García et al., 2005; Millard, 2006; Özdemir et al., 2010).

Diagenesis is defined as a cumulative, physical, chemical and biological process occurring in soil, changing the post-mortem chemical and physical structures of bones. As a result, it manipulates both preservation and destruction mechanisms and particularly leads to increases in the levels of toxic metals (Wilson and Pollard, 2002). In this respect, Zapata et al. (2006) point out that factors such as elemental and mineralogical composition of bone and surrounding soil along with geologic, climatologic and groundwater characteristics of burial environments are critical to understand the potential stress of diagenesis on archaeological human bones. Additionally, contamination coming from agricultural chemicals, artesian wells and mining activities should also be taken into consideration.

The aim of this study is to make contribution to the archaeological studies currently being conducted in Resuloğlu excavation area through adding the perspective of chemical analysis. We believe that more could be understood about interactions among their lifestyle, metal objects and the environment through ascertaining some toxic and essential elements on bones and in soil and water samples as well as diagenetic factors.

Resuloğlu excavation site

The Early Bronze Age settlement at Resuloğlu and its burial site are within the district of Uğurludağ in Çorum province, Turkey (Figure 1). Both the settlement and burial site are located 1300 m northwest of Resuloğlu Village. The graves lie on a ridge between two mound-type settlements on the top of the ridge facing to the southeastern mound. The settlements are in a considerably strategic location overlooking the Delice River valley, from Kavsut in the south through Kula, where it meets with Kızılırmak (Halys) river. The archeological importance of this region is marked by the well-known Kaleboynu mound—also known as Kaletepe mound—which has been inhabited since prehistoric times, most notably during the Roman, Byzantine and the Middle ages (Yıldırım, 2006). Building activities just to the north of the cemetery area can be related to the population increase of Resuloğlu settlers (Yıldırım, 2006). The excavations of Resuloğlu cemetery were begun in 2003 and they are maintained to support new information about burial rites and raw material consumption of a local EBA culture. Three types of graves, pithoi, cists and jars, were observed in Resuloğlu cemetery. Burial gifts are generally composed of pottery, metal vessels, weapons and jewelry (Figure 2). Additionally, the state of preservation of these gifts is considerably good. It has been observed that pendants, beads and necklaces had been made of various materials such as frit, faience, marine shells, stone, limestone, malachite, carnelian, arsenical mineral (uzonite), copper/bronze, silver, gold and occasionally electrum (Yıldırım, 2006).

According to the first results of X-Ray Diffraction (XRD) and destructive X-Ray Fluorescence (XRF) analyses, high concentrations of tin and arsenic were detected among Resuloğlu metallic items. Thereafter it was understood that the high tin values are almost a common feature for bronze jewelry found in Resuloğlu site. Nevertheless, it is known that adding tin in such high values has no positive contribution to smelting, alloying or hardening process of the object (Yıldırım and Zimmermann, 2006, 2007). Yıldırım and Zimmermann (2007) have thought that the reason high tin use must have been an attempt to manipulate the color of objects to receive a more 'silvery sheen.' Moreover, they have suggested, "the idea of exploiting nearby small sources of tin or tin-related minerals as a reasonable alternative to the theory of long-distance tin trade from the Middle East in third millennium BC."

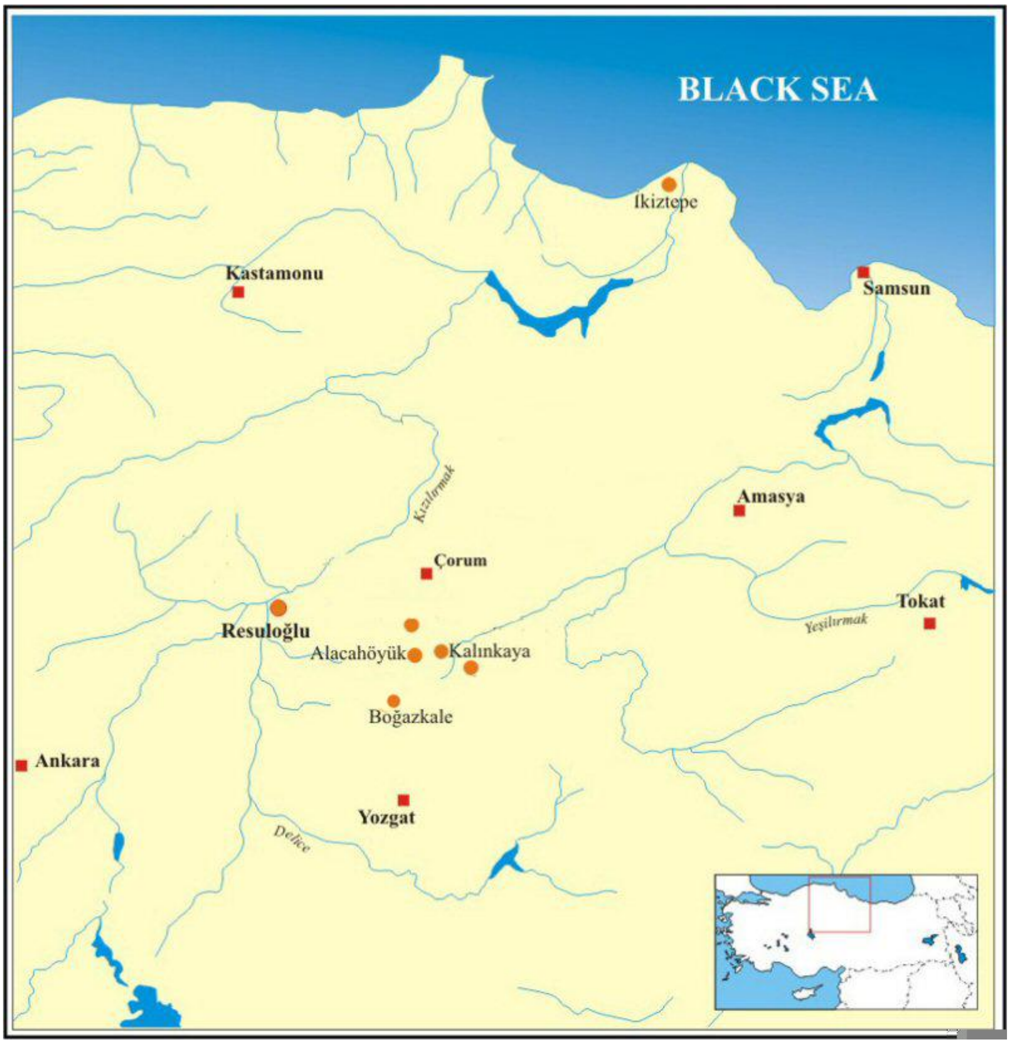

Figure 1: Location of Resuloğlu excavation area (Yıldırım and Zimmermann, 2007)

Figure 2: One of the burials with metal objects found in Resuloğlu (Yıldırım and Zimmermann, 2007)

Materials and methods

Fragments of rib bones belonging to 81 individuals acquired from Resuloğlu EBA burial site during 2003-2007 excavation seasons have been used in the present study. The anthropological and demographic analysis of these series has been recently published in which it was ascertained that the Resuloğlu skeletal population involves individuals from all ages (Atamtürk and Duyar, 2009, 2010). Additionally, some traces have been detected indicating exposure to physical stains on bones. Both the age and sex of the individuals in this study has been determined based on standards adopted by Buikstra and Ubelaker (1994).

One tenth g specimen was weighed from each rib bone which was previously cleaned by distilled water and then pulverized using a Janke and Kunkel Ultra-Turrax T25 homogenizer. Afterwards, bone powder was enclosed in microwave test tubes and 5 ml nitric acid (HNO_3) on top of a 5 ml hydrogene peroxide solution was added to the samples. The blends were kept in the tubes approximately half an hour. The solutions were burned totally using 1600W Cem Mars Xpress microwave oven at 210 ^{0}C for 10 minutes and were kept 5 minutes more in the oven just after the procedure was completed. Every sample was transferred from microwave test tubes to polypropylene flasks and then filled with distilled water up to reach a volume of 50 ml. Additionally, potassium iodide (KI) was added to the flasks so as to detect arsenic (As). All of the samples were kept at +4 ^{0}C in a refrigerator. Ultra pure nitric acid and deionized water were used throughout all analyses.

The analyses of lead (Pb) and cadmium (Cd) were made using Varian AA 240 Z Zeeman Graphite Atomic Absorption Spectrometry (GFAAS), while copper (Cu) and zinc (Zn) were evaluated with Varian AA 240 FS Fast Sequential Atomic Absorption Spectrometry (FSAAS). Arsenic (As), however, was measured with hydride system. The results of bone analyses were given as ppm for Zn, Cu, Cd, Pb, and As. Furthermore, all samples were certificated with standard reference material NIST-SRM 1400 (bone ash) for the validation of the analytical method.

Soil and water analyses were also performed to comprehend the extensity and the effects of either diagenesis or environmental factors more clearly as cited in Özdemir et al. (2010). For these aims, soil samples were gathered from five different regions of the excavation area and they were taken 20-25 cm below from the ground in order to prevent any contamination and to understand the difference between earliest and most recent soil formations. Five tenth g soil was taken from each sample and dried at 75 ^{0}C during 24 hours in an incubator then enclosed to vessels. Burning procedures of the soil samples were defined based on Ethos Plus application note 031 (June 2000) asserting acid digestion of a soil sample in a closed vessel, and the elemental analyses of the soil samples were performed using the same protocols and devices as used with the bone specimens.

Furthermore, 10 water samples were collected from five different sources of the field. pH values of the water samples were measured with the help of a pH meter and found that they were in range between 6.9-7.3. Sufficient amount of water samples were transferred to polypropylene flasks and added 1% nitric acid. These samples were also analyzed using same methods and equipment like bones and soils. Similarly, descriptive statistics of both soil and water samples were calculated taking the means of five different regions in the excavation site.

Statistical analysis of the results was interpreted using IBM SPSS Statistics 19 software package. Descriptive statistics comprised of mean, standard deviation, coefficient of variation, minimum and maximum values were calculated. Taking into consideration the sample size, non-parametric tests were performed in order to define significance levels as regards sex (Mann-Whitney U test), age groups (Kruskal-Wallis test) and their differences (Mann-Whitney U test). Additionally, only one parametric test (independent sample *t*-test) was performed on samples so as to find significance levels with regards to being buried with gifts or not. Other than significant tests, Pearson correlation coefficients were computed for all elements. The minimum confidence levels were chosen as 95% (P<0.05) and 99% (P<0.01).

Results

The results of elemental analysis of the Resuloğlu skeletal series are tabulated separately in the Appendix. As can be seen, our samples exemplify the population of Resuloğlu in terms of variation among both age groups and sexes. Moreover, the descriptive statistics of the samples are organized according to three age groups seen in Table 1.

The age groups are arranged into three ranges: age group I (0-17 years), age group II (18-34 years) and age group III (35 years and over). The descriptive statistics of the results of soil and water samples are given in Table 3. Every mean is computed based on the means of five regions.

Zn values of bone sample range between 103.96 and 837.34 ppm with the average of 267.14 ppm (Table 1). Age group III has the highest mean Zn level (267.14 ppm); on the other hand, age group II has the lowest level (249.41 ppm) among all of the three groups. Although some differences are found in terms of sex and burial gifts, they are not statistically significant.

Cu analyses of bone samples range between 1.99 ppm and 396.46 ppm with the average of 38.47 ppm (Table 1). Age group I has the highest mean Cu value (66.83 ppm) amongst the other age groups. Moreover, Cu concentrations are higher in subadults than in adults. The lowest mean Cu value has been found in age group III (23.37 ppm). Cu values are statistically significant in between age groups (Kruskal-Wallis, χ^2 = 7.63, P< 0.05). However, there is no significance between Cu values and sex or burial gifts.

Table 1: Descriptive statistics of elements analyzed in Resuloğlu population

	Zn (ppm)	Cu (ppm)	Cd (ppm)	Pb (ppm)	As (ppm)
Total (N=81)					
Mean	267.14	38.47	0.49	3.81	15.15
SD	156.79	74.74	0.46	5.16	7.71
CV	58.69	195.31	93.82	135.43	50.88
Minimum	103.96	1.99	0.13	0.87	0.35
Maximum	837.34	396.46	2.95	34.89	36.43
Age Group I (0-17 years) (N = 23)					
Mean	268.44	66.83	0.38	4.19	14.53
SD	175.02	109.60	0.19	5.82	5.98
CV	65.20	164.01	50.42	139.02	41.19
Minimum	106.85	4.15	0.13	0.98	0.68
Maximum	683.96	396.46	0.92	30.06	27.16
Age Group II (18-34 years) (N = 20)					
Mean	249.41	33.73	0.34	3.12	15.04
SD	167.74	49.60	0.17	2.10	9.71
CV	67.25	147.07	49.87	67.43	64.54
Minimum	103.96	1.99	0.15	0.96	0.35
Maximum	837.34	170.20	0.68	8.89	34.99
Age Group III (35 years and over) (N = 38)					
Mean	275.68	23.37	0.63	3.95	15.58
SD	142.29	54.10	0.61	5.90	7.63
CV	51.62	231.47	96.77	149.38	49.01
Minimum	118.19	3.01	0.16	0.87	5.21
Maximum	686.67	288.06	2.95	34.89	36.43
P value	NS	$P< 0.05$	$P< 0.05$	NS	NS

SD: Standard deviation
CV: Coefficient of variation
NS: N ot significant

Cd values range between 0.13 ppm and 2.95 ppm with the average of 0.49 ppm (Table 1). The lowest mean Cd value belongs to age group I (0.38 ppm) whereas age group III has the highest value (0.63 ppm). Similar to Cu values, the only statistical significance has been observed across age groups (Kruskal-Wallis, $\chi^2 = 8.25$, $P< 0.05$).

Pb values range between 0.87 ppm and 34.89 ppm with the average of 3.81 ppm (Table 2). The highest mean Pb value belongs to age group I (4.19); at the same time, the means of the other age groups seem to have approximated values with one another (Table 2). Overall, no statistical test is significant for Pb values.

In a similar way, the mean As values of the each age group are notably close to each other. Age group I has the lowest mean As value (14.53 ppm). However, no statistically significant result has been found based on As levels from all the tests related with sex, burial gifts or across age groups.

A correlation matrix of five metals has also been presented in Table 2. The highest correlation coefficients have been found between Zn and Cd in addition to Pb and Cd (Pearson correlation, $r = 0.47$, $P<0.01$; $r = 0.43$, $P<0.01$), respectively. Furthermore, correlations between Cd and As on top of Pb and Zn have higher values (Pearson correlation, $r = 0.23$, $P<0.05$; $r = 0.22$, $P<0.05$), respectively. In view of age groups, the correlation between the age groups and Cd value is higher (Pearson correlation, $r = 0.26$, $P<0.05$) whereas the correlation between the age groups and Cu is higher and inverse (Pearson correlation. $r = -0.24$, $P<0.05$). No significant correlation was found for either sex or burial gifts among all elements.

In order to detect the effect of diagenesis, we measured the levels of elements in soil and water samples gathered from five distinct regions of the excavation area. The tabulated descriptive statistics can be found in Table 3.

Table 2: Pearson's correlation matrix for elements studied

Elements	Zn	Cu	Cd	Pb	As
Zn	1.00				
Cu	0.12	1.00			
Cd	0.47**	-0.11	1.00		
Pb	0.22*	-0.23	0.43**	1.00	
As	0.18	-0.11	0.23*	0.27	1.00

* $P < 0.05$
** $P < 0.01$

Table 3: Descriptive statistics of soil and water samples gathered from Resuloğlu excavation area

	Zn	Cu	Cd	Pb	As
Soil (ppm) (N= 5)					
Mean	40.76	13.84	0.06	0.45	1.56
SD	3.39	1.37	0.01	0.10	0.11
Minimum	35.53	11.45	0.05	0.34	1.45
Maximum	45.97	15.05	0.07	0.69	1.83
Water (ppb) (N=5)					
Mean	20.82	14.05	0.02	0.19	0.47
SD	4.71	8.47	0.01	0.05	0.19
Minimum	12.88	6.35	0.01	0.11	0.22
Maximum	26.80	32.78	0.03	0.27	0.87

SD: Standard deviation

Discussion

When our outcomes are compared with the data collected from the İkiztepe skeletal series (Özdemir et al., 2010), located considerably near to Resuloğlu and in the same historic period, it can be seen that average Cu level, 38.27 ppm, is higher in Resuloğlu specimens when compared to the 24.80 ppm found in the İkiztepe population. The mean Pb values, 3.81 ppm, however, are much lower by contrast with 21.10 ppm in İkiztepe. On the other hand, average As levels are quite close in the two studies (15.15 ppm versus 15.00 ppm, respectively). Comparing the mean values of prior to Bronze Age bones in the study conducted by Martínez-García et al (2005) to those found in this EBA study, the average Zn, Cu, Cd and Pb values are 131.00 ppm, 13.49 ppm, 0.21 ppm and 22.98 ppm, respectively, while our findings were 267.14 ppm, 38.27 ppm, 0.49 ppm and 3.81 ppm, respectively.

It is known that Resuloğlu area has rich Cu, Pb, Zn, Fe and Mn ore deposits within its boundaries (Figure 3).

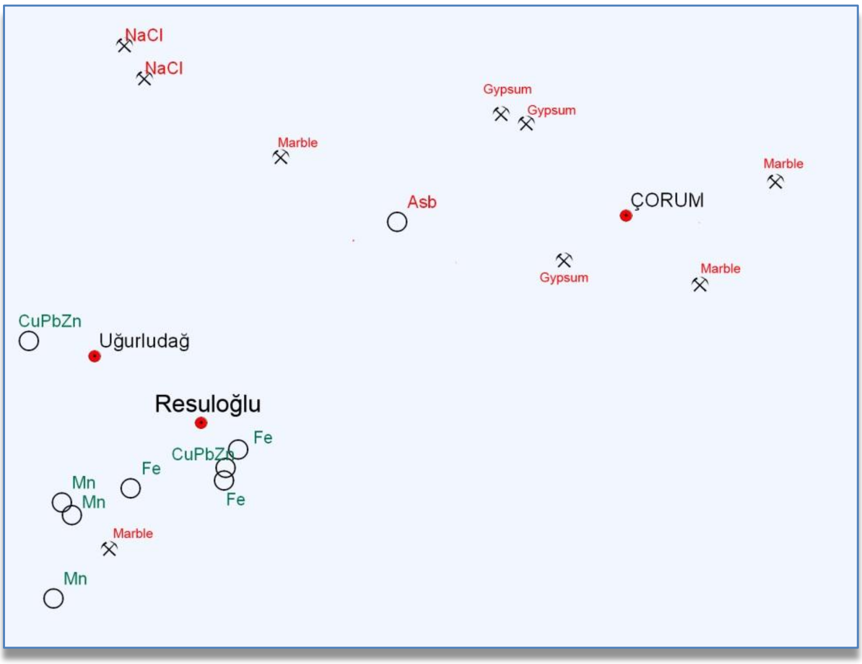

Figure 3: Mineral map of Çorum province (adapted from (MTA, 2010)

Additionally, it is comprised of moors and relatively arid soils. In long-term arid climates, post-mortem decomposition of organic material takes longer time and this fact leads to retard ion exchanges (Iacumin et al., 1996; Iacumin et al., 1998). In some studies performed on industrial workers exposed especially to Pb and Cu, the mean lead level has been found as 40 ppm (Ahlgren et al., 1976; Ahlgren and Mattsson, 1979) as cited in Grattan et al. (2002). On the other hand, the mean lead value found among individuals in the population of Wadi Faynan, known as one of the major centres of copper mining and smelting in the ancient world investigated by Grattan et al. (2002), was 42.49 ppm. Similarly, the mean copper concentration of Wadi Faynan individuals was high (52.57 ppm). When these two sets of data are compared with our analyses, it can be realized that both the mean lead and copper values of Resuloğlu settlers are lower. For this reason, we can interpret that the toxic metal accumulations did not originate from either lifestyles or lifetime exposure. The mean metal concentrations of the studies mentioned above as well as additional studies has been comparatively tabulated below (Table 4).

The main conclusions reached by other researchers of these studies listed in Table 4 attribute the presence of varied levels of trace elements to proximity to metal deposits (Grattan et al., 2002), chronic exposure due to smelting work (Grattan et al., 2005) and diagenesis (González-Reimers et al., 2001; Lambert et al., 1979; Martínez-García et al., 2005; Özdemir et al., 2010; Zapata et al., 2006). Assuming that these factors hold the greatest influence, the values for the elements represented on Table 4 seem extremely high.

To understand more about the origin of accumulation and exposure level, we calculated the ratio between average concentrations of each element in the bones and the mean levels of soil concentrations based on the studies performed by Grattan et al. (2002) and (2005) and Özdemir et al. (2010). According to the results, bone/soil ratios of Zn, Cu, Cd, Pb and As are: 6.5:1; 2.8:1; 8.2:1; 7.6:1 and 9.7:1; respectively. In terms of Cu, Pb and As, the calculated bone/soil ratios are excessively higher than those noted in the study by Özdemir et al. (2010), 1.3:1, 4.6:1 and 2:5:1, respectively. The soil/bone ratio for arsenic in the Resuloğlu samples is close to 9.5:1, however higher than the ratio (7.3:1) calculated in the study by Oakberg et al. (2000). It is known that arsenic retentions arise from diagenetic mechanisms in these studies. Moreover, it is established that rich Cu, Pb, Zn, Fe and Mn ore deposits are present next to Resuloğlu excavation site (Figure 3).

Table 4: Comparison of mean metal concentrations belonging to some reference found in the literature compared with the outcomes of Resuloğlu

Site	Period	Reference	N	Zn (ppm)	Cu (ppm)	Cd (ppm)	Pb (ppm)	As (ppm)
İkiztepe, Turkey	EBA	Özdemir et al. (2010)	90	-	24.80	-	21.10	15.00
Puerto de Mazarrón, Spain	Late Antique 4th -6th Cen., AD	Zapata et al. (2006)	84	133.00	12.00	-	225.00	-
Cartagena, Spain	EBA	Martínez-García et al. (2005)	4	131.00	13.49	0.21	22.98	-
Gran Canaria, Spain	Bronze Age	González-Reimers et al. (2003)	16	-	-	0.85	4.06	-
Wadi Faynan, Jordan	Late Antique 4th -7th Cen., AD	Grattan et al. (2002)	36	-	52.57	-	42.49	-
Shiqmim, Israel	Chalcolithic 5th -4th Mil., BC	Oakberg et al. (2000)	12	-	-	-	-	5.3 (ppb)
Gibson, USA	Ca. 175±80, AD	Lambert et al. (1979)	86	302.00	10.60	-	-	-
Resuloğlu, Turkey	EBA	This study	81	267.14	38.27	0.49	3.81	15.15

Considering both bone/soil ratios and the distance to ore deposits, we also assert that the fundamental reason behind this accumulation is caused by diagenetic factors. But, Cu concentration one among seven metals analyzed by Yıldırım and Zimmermann (2007), of burial gifts is quite higher (average 89.59 ppm) than the mean Cu level of soil. For this reason, it is considered that the major factor behind Cu retention in the Resuloğlu Central Anatolian EBA skeletal population may not only be due to diagenesis but also from burial gifts made out of bronze. Finally, the averages of metal concentrations in groundwater found through water analysis appear relatively lower than the values derived from bones and soil (Table 3). This suggests that water is not a source of element retention in the Resuloğlu specimens.

Conclusion

In this study we have presented the levels of Zn, Cu, Cd, Pb, and As belonging to a skeletal series unearthed from the Resuloğlu EBA necropolis in Çorum province, Turkey. Analysis of element concentrations in bones as well as soil and groundwater support the conclusion that the main reason behind such high accumulations is due to diagenetic mechanisms. While Atamtürk and Duyar (2010) cite in a previous study that the Resuloğlu inhabitants display characteristics of both preliminary and intensive agricultural lifestyle, more information is necessary to determine whether smelting was also practiced. We also know that three types of graves, pithos, cist and jar graves, were found in the region and that all individuals, both children and adults, were placed in hocker or nim-hocker positions into these graves and occasionally multi-burials can be observed. One factor that needs more investigation is the skeletons exhumed from the graves without burial gifts. These specimens have been found partially destroyed and robbed by illegal digs. Learning more about the history of these skeletons could shed some light on additional causes of the concentrations of elements found in the Resuloğlu population.

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Appendix: Information and the outcomes of Resuloğlu skeletal series

Recording number	Age group	Sex	Burial gift	Zn	Cu	Cd	Pb	As
Ro-04	Infant	Male	-	108.56	29.12	302.50	5.59	0.68
M-2	Infant	Undefined	+	144.92	10.98	224.92	0.98	18.40
M-37	Infant	Undefined	-	106.85	9.59	214.43	2.03	12.64
M-164	Infant	Undefined	+	269.69	12.68	246.51	3.96	19.92
M-171	Infant	Undefined	+	231.87	7.76	357.28	4.47	12.06
M-70	Child	Male	+	130.14	14.73	422.51	5.47	8.32
M-14	Child	Undefined	-	187.32	29.14	234.14	1.99	12.63
M-21	Child	Undefined	-	381.88	8.10	449.06	30.06	16.45
M-24/1	Child	Undefined	-	546.39	267.61	400.23	1.23	9.35
M-65/1	Child	Undefined	-	188.56	317.43	298.79	3.40	12.98
M-83	Child	Undefined	+	148.28	25.71	146.74	2.94	11.85
M-99/2	Child	Undefined	-	132.66	6.79	555.99	1.58	11.29
M-122	Child	Undefined	+	211.57	88.06	379.79	2.62	9.77
M-124	Child	Undefined	+	226.15	4.15	475.42	2.20	16.22
M-125	Child	Undefined	-	683.96	33.49	915.40	2.36	10.31
M-148	Child	Undefined	+	170.66	20.37	388.93	5.38	22.08
M-160	Child	Undefined	+	580.75	396.46	256.86	2.70	21.56
M-168/2	Child	Undefined	-	262.45	8.27	133.52	2.16	22.46
M-170	Child	Undefined	+	188.01	37.26	373.34	2.26	16.44
M-179/1	Child	Undefined	+	287.99	6.40	512.40	1.21	18.53
M-186	Child	Undefined	-	175.46	44.99	308.64	3.87	27.16
M-200	Child	Undefined	+	642.61	11.86	807.25	2.34	15.95
M-120	Child	Undefined	+	167.38	146.14	271.15	5.54	7.08
M-130	Adolescence	Female	+	837.34	12.36	476.02	2.98	22.78
M-188/2	Adolescence	Male	-	195.01	19.31	271.36	2.67	23.10
M-185	Young adult	Female	+	103.96	34.42	443.86	8.89	18.88
M-17/3	Young adult	Female	-	221.31	170.20	498.69	2.01	8.44
M-7	Young adult	Female	-	124.69	6.92	161.83	6.37	0.35
M-8/1	Young adult	Female	+	240.84	10.95	153.24	1.49	2.27
M-41	Young adult	Female	+	106.17	8.94	223.85	5.05	5.95
M-49	Young adult	Female	-	260.82	6.94	206.90	1.85	9.31
M-66	Young adult	Female	+	126.12	15.03	587.57	3.98	7.64
M-146	Young adult	Female	+	415.22	143.62	234.73	5.21	13.30
M-178	Young adult	Female	+	314.66	6.94	677.99	1.22	21.89
Unnumbered	Young adult	Female	-	253.68	14.36	472.68	5.39	20.90
M-126/1	Young adult	Female	+	402.51	11.23	251.66	3.56	34.99
M-36/1-2	Young adult	Male	-	115.25	13.30	360.54	1.12	7.54
M-61	Young adult	Male	-	217.38	14.58	166.13	0.96	7.28
M-67	Young adult	Male	-	161.82	14.49	636.30	1.41	15.49
M-68	Young adult	Male	+	195.01	122.75	281.01	1.82	9.94
M-138	Young adult	Male	+	364.06	39.72	309.56	2.38	11.82
M-177	Young adult	Male	-	148.04	6.53	168.36	2.11	31.27
M-172/1	Young adult	Undefined	-	184.22	1.99	205.60	1.84	27.66

M-11	Middle adult	Female	+	425.71	26.20	1457.14	0.87	8.95
M-19	Middle adult	Female	+	407.66	8.17	618.81	2.13	10.41
M-20/2	Middle adult	Female	-	171.18	5.57	160.41	0.96	8.75
M-28/2	Middle adult	Female	-	264.69	14.00	216.43	1.19	11.60
M-41 2/3	Middle adult	Female	-	152.81	12.35	372.47	5.22	6.96
M-46/ 1	Middle adult	Female	+	149.51	10.54	370.90	2.05	6.22
M-56	Middle adult	Female	-	346.39	17.39	514.70	3.03	8.27
M-77/2	Middle adult	Female	-	237.28	11.72	582.61	1.50	17.84
M-84	Middle adult	Female	+	197.59	13.14	456.71	9.74	13.13
M-94	Middle adult	Female	+	317.05	8.44	534.80	2.71	9.59
M-127/2	Middle adult	Female	-	313.60	8.90	589.40	2.35	21.47
M-151	Middle adult	Female	-	237.00	6.85	273.49	1.61	16.51
M-169	Middle adult	Female	+	231.88	5.94	475.12	1.12	13.69
M-195	Middle adult	Female	-	153.65	12.58	387.41	2.07	24.72
M-196-oh	Middle adult	Female	-	208.61	7.96	216.01	1.97	23.19
M-35	Middle adult	Male	+	118.19	8.09	227.98	2.71	11.16
M-43	Middle adult	Male	-	226.49	6.25	166.23	1.89	5.21
M-81	Middle adult	Male	-	127.65	10.40	819.03	1.32	16.59
M-89/1	Middle adult	Male	+	355.87	35.05	876.86	3.80	13.49
M-89/2	Middle adult	Male	-	440.22	20.12	449.29	3.11	13.28
M-91	Middle adult	Male	+	148.19	288.06	280.89	1.54	14.93
M-99/1	Middle adult	Male	+	129.26	6.06	298.23	2.92	9.53
M-123	Middle adult	Male	+	132.81	10.53	326.98	3.93	7.80
M-126/2	Middle adult	Male	-	357.34	3.17	521.55	2.39	15.44
M-141	Middle adult	Male	+	553.68	22.25	2853.50	34.89	23.20
M-144	Middle adult	Male	+	686.67	9.25	1101.22	2.29	18.27
M-168/1	Middle adult	Male	+	364.52	6.19	876.24	3.22	19.35
M-188/1	Middle adult	Male	+	209.98	10.04	292.56	2.97	27.89
M-191	Middle adult	Male	+	187.34	16.58	232.33	1.78	36.43
M-193	Middle adult	Male	+	277.17	9.49	785.22	1.50	22.63
M-198	Middle adult	Male	+	181.26	6.04	309.65	1.83	25.11
M-199/1	Middle adult	Male	-	453.38	4.27	2945.88	3.34	35.02
M-60	Old Adult	Female	-	127.29	9.09	348.80	1.92	10.45
M-77/1	Old Adult	Female	-	166.44	200.22	470.86	8.47	5.88
M-149	Old Adult	Female	-	359.11	3.01	629.74	5.36	13.39
M-184	Old Adult	Female	+	163.85	12.18	315.15	2.21	19.62
M-28/1	Old Adult	Male	+	623.64	16.43	1118.27	16.38	11.31
M-196	Old Adult	Male	+	270.87	5.67	590.75	1.82	14.63

Burial gift: Available (+)/ Unavailable (-)