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The production of metal artefacts in Southern Etruria (Central Italy): case studies from copper to Iron Age

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ABSTRACT

An analytical study is presented, aimed to determine the elemental composition of copper-based artefacts dated back from Copper Age to Early Iron Age (mid-fourth millennium to the VIIIth century B.C.), found on the Tyrrhenian side of the peninsula, corresponding to the Lazio region. The objects belong to different archaeological contexts and had various functions. They were analysed by the X-ray fluorescence technique. The results highlight the experimental character of Copper Age metallurgy, which will later evolve in the established use of copper-tin alloys. Regarding the Bronze Age, despite the typological and functional heterogeneity of the artefacts and the wide chronological range, the alloys are relatively homogeneous in composition, with regular changes that appear related to chronology, according to what is already known for the Italian peninsula. Such changes are supposedly due to variations in the availability of tin, which was not locally mined. Early Iron Age metallurgy is represented by the Selvicciola Hoard solely, which restricts the possibility of generalizing the conclusions. A striking feature of the alloys is the great compositional difference between the complete and the fragmented artefacts. The formers are made of tin bronze, whereas in the latter tin is replaced by antimony and/or lead. The use of such unusual alloys is unlikely due to lack of metallurgical knowledge. Considering the urbanized communities that arose in the Middle-Tyrrhenian area during the Early Iron Age, we suppose that such variability in a single context might be related to a production system capable of using alloys of different quality and value to satisfy a diversified demand.

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Prehistoric metallurgy; Southern Etruria (Italy); X-ray fluorescence (XRF); Eneolithic; Bronze Age; Iron Age

Introduction

The first studies concerning the elemental composition of prehistoric metal artefacts date back to 50s and the 60s of the past century (Otto and Witter 1952; Junghans, Sangmeister, and Schröder 1960, 1968, 1974). Although they included Italian findings too, this approach to the study of early metallurgy (Dolfini and Giardino 2015) played a back-line role among Italian scholars. Only in recent decades, it gave rise to systematic research projects like, for instance, the examination of the prehistorical bronzes at the Museo Civico di Storia Naturale of Verona (Aspes 2011).

The present paper reports the first – partial and provisional – outcomes of a research carried out in the framework of the Memorandum of Understanding signed in 2017 between the Soprintendenza Archeologia per il Lazio ed Etruria Meridionale and the Istituto Nazionale di Fisica Nucleare-Laboratori Nazionali di Frascati (INFN-LNF), which aimed to share research, scientific advice and training related to prehistoric metallurgy.

The research regards the systematic analysis of pre – and proto-historic metallic findings coming from areas in the provinces of Rome and Viterbo, in Central Tyrrhenian Italy. The typology of the items and the size of the groups is affected by the vicissitudes of archaeological research and by events that sometimes brought to spread unitary contexts in different museums. Thus, the artefacts are not homogeneously distributed from a geographical point of view: at present, most objects come from an area between the Middle Valley of River Fiora and the lake Bolsena, for the north, and an area among the Tyrrhenian Coast, the Tolfa mountains and the lake Bracciano, for the south (Appendix and Figure 1).

The objects so far examined cover a chronological range which conventionally spreads from the beginning of the Eneolithic (mid-fourth millennium B.C.) to the Early Iron Age (XIth-VIIIth century B.C.). It is not aim of the present paper to discuss the chronological attribution of the artefacts. It is taken from the cited

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Figure 1. Geographical context of the artefacts; blue and red colors locate the northern and the southern area, respectively.

literature and assumed correct. The items come from different types of archaeological contexts and many are isolated findings. Their function is not always unambiguously recognized: they might have been for daily use or be valuable and ceremonial artefacts. At the end of the research, it will be possible to use the function as a variable together with geographic distribution and chronology, since it might have affected the choice of the alloy and the production technique.

Experimental method

Analyses of the artefacts were performed by X-ray fluorescence (XRF) (Ferretti 2014), on surfaces from which corrosion products had been previously removed. The experimental conditions are summarized in Table 1. They are established to provide both efficient excitation and well-resolved detection of such key role elements as Ag, Sn and Sb. In such conditions, detection limits calculated with the single standard method (Jenkins, Gould, and Gedke 1995) are approximately 400 mg/kg for Fe and Ni, 250 mg/kg for Zn, 50 mg/kg for Ag, Sn, Sb and 300 mg/kg for Pb. The overall relative accuracy is 5–10% for all elements. Accuracy is estimated by calibration standards as the mean deviation between the measured and the nominal concentration. Quantification was carried out by the combined use of calibration standards and the PyMCA Fundamental Parameters software package (Solé et al. 2007). The only exception is for As, whose quantification relies on Fundamental Parameters solely. Whenever possible, multiple measurements were performed on different parts of the object, depending on the size and conservation conditions. All the charts shown in the subsequent sections refer to mean values calculated over all the measurements performed on the object.

Table 1. Experimental conditions of the XRF measurements.

Source	X-ray tube, 60kV, 1.5 mA
Beam filter	0.3 mm Cu
Primary collimator	1.7 mm in diameter
Detector	7 mm^2 Silicon Drift

Experimental results and discussion

A detailed description of the investigated artefacts, the normalized composition for each measurement (Table A1) and the mean composition of each artefact (Table A2) are given in the Appendix.

This work refers to copper-based alloys solely, whereas objects containing silver, antimony and lead as main components are not included. It is immediately apparent that the observed compositional differences are correlated to the development of metallurgical know-how and, therefore, to the chronology of the artefacts. This aspect is examined and discussed widely

in the literature for other contexts of the same period, in different areas of the Italian peninsula.

Eneolithic

The most ancient period here considered corresponds to the chronological range of Eneolithic (in Italy between the mid-fourth and the end of the IIIrd millennium B.C.).

The objects are axes, dagger blades and awls; halberd blades were not considered since this kind of artefacts is missing in the local museums involved in this project.

A preliminary analysis of the data set shows differences in the contents of Co, Zn, As and Sb seemingly related to the area they come from. Figures 2 and 3 show the Zn-Co and Sb-Zn scatterplots, respectively.

Although the groups are not equally numerous, which affects the significance of the comparison, they suggest the use of differnt ore sources. Even though Co concentrations are close to the detection limit, it can be observed that artefacts from the northern area tend to be higher in Co and lower in Zn, respect to

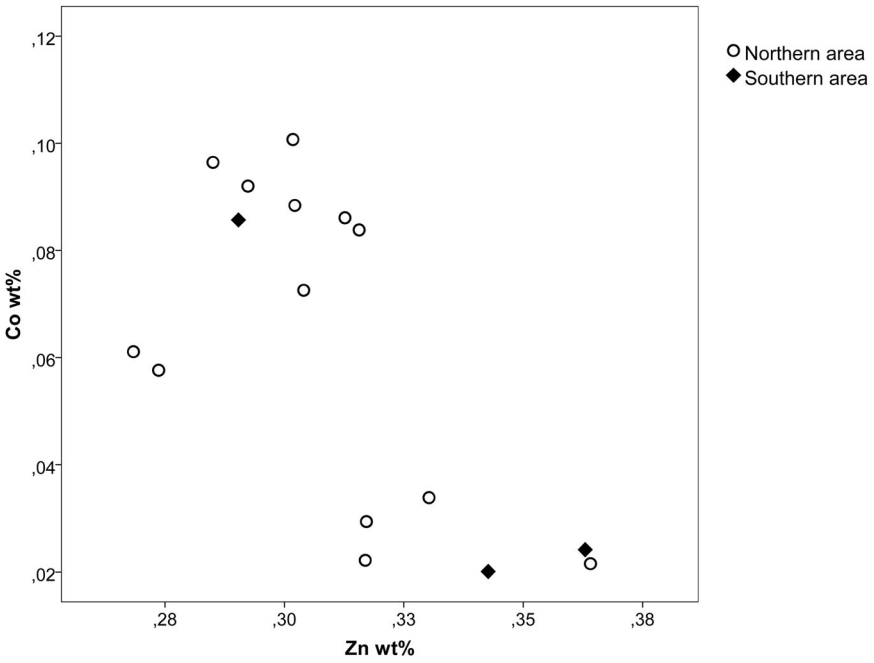

Figure 2. Zn-Co scatterplot for the Eneolithic artefacts; circles and diamonds refer to the northern and southern areas, respectively.

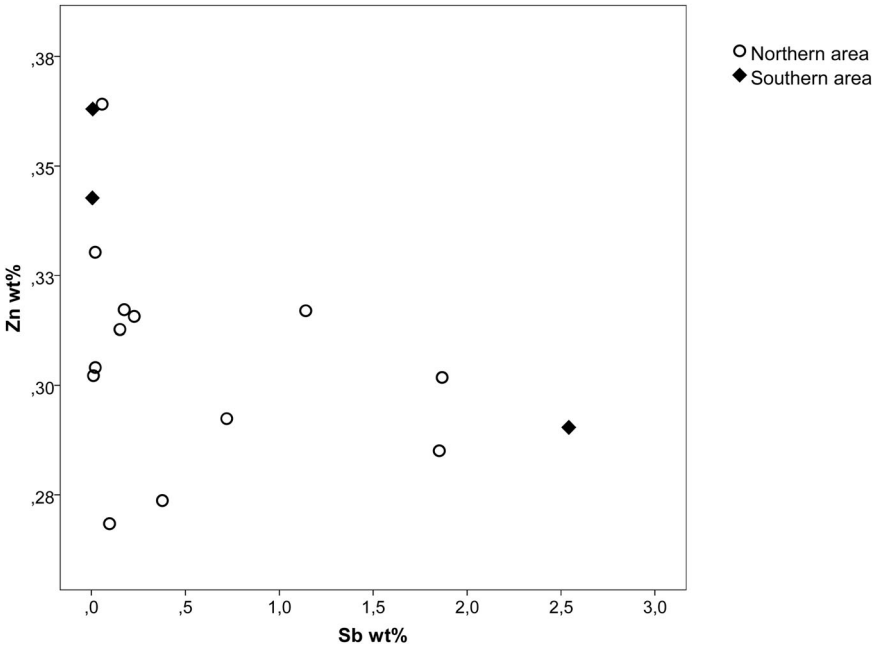

Figure 3. Sb-Zn scatterplot for the Eneolithic artefacts; circles and diamonds refer to the northern and southern areas, respectively.

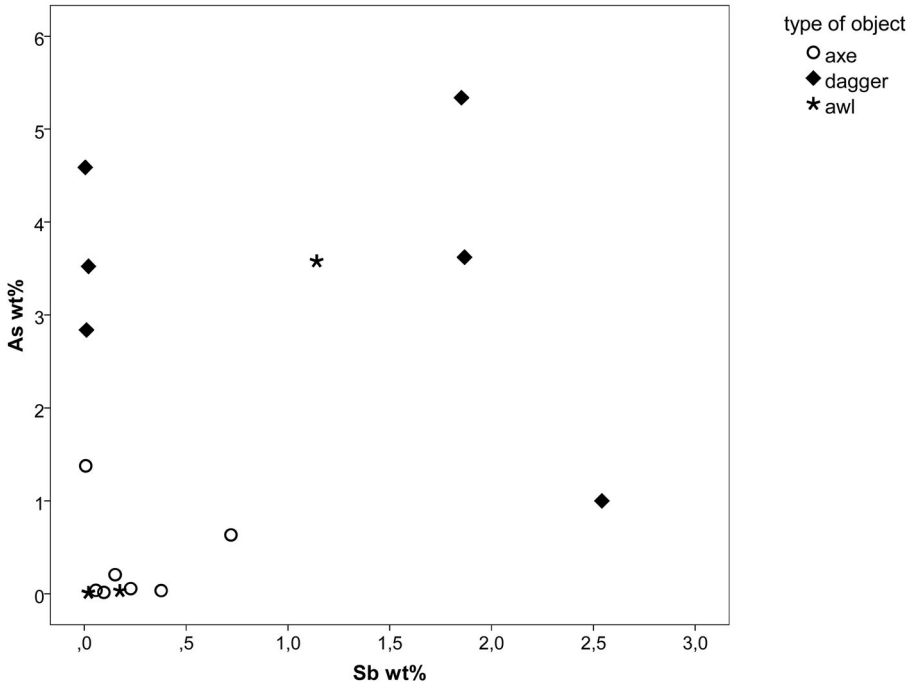

Figure 4. Sb-As scatterplot for the Eneolithic axes (circles), daggers (diamonds) and awls (stars).

the southern one. Moreover, the artefacts from the northern area tend to be high in Sb, except for the dagger blade Selvicciola necropolis 3.

Figure 4 shows the Sb-As scatterplot for axes, daggers and awls solely. It appears that different alloys were used for axes and daggers, with the latter characterized by a variable but detectable presence of As and Sb. Three different groups can be distinguished: the first group has relatively high As and low Sb; the second group has high As and high Sb and the third group, consisting in a single item, has low As and high Sb. Figure 4 also shows that As content of the daggers is significantly higher than 1 wt%, which leads assuming that it was deliberately alloyed with copper and that this was a common practice in both areas.

Figure 5 goes deeper in detail and compares the compositional profiles of the dagger blades. The bars account for the mean concentration calculated over all the measurements performed on the item.

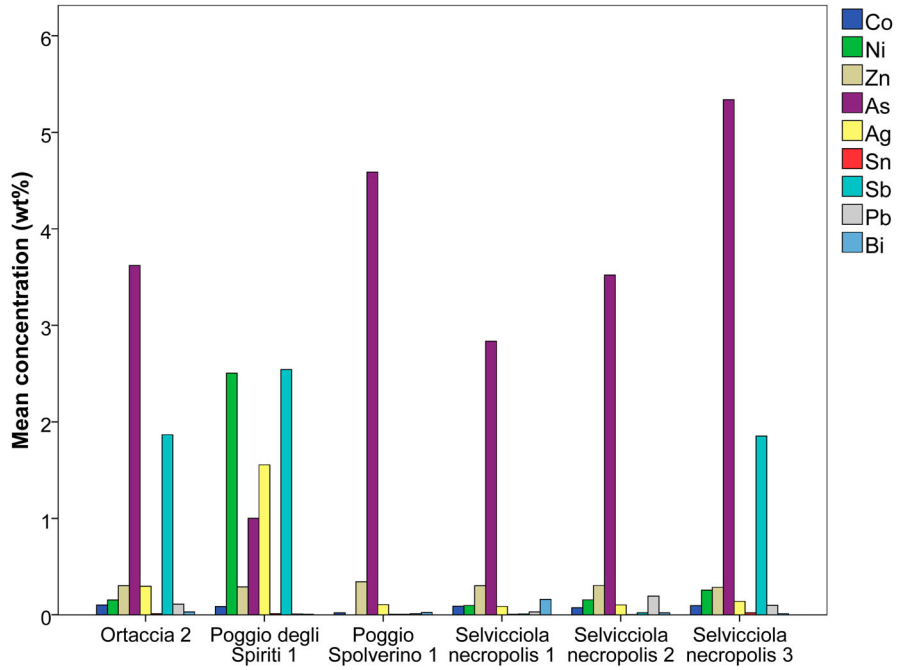

Figure 5. Compositional profiles of the Eneolithic daggers; bars account for the mean concentration calculated over all the measurements performed on the single item.

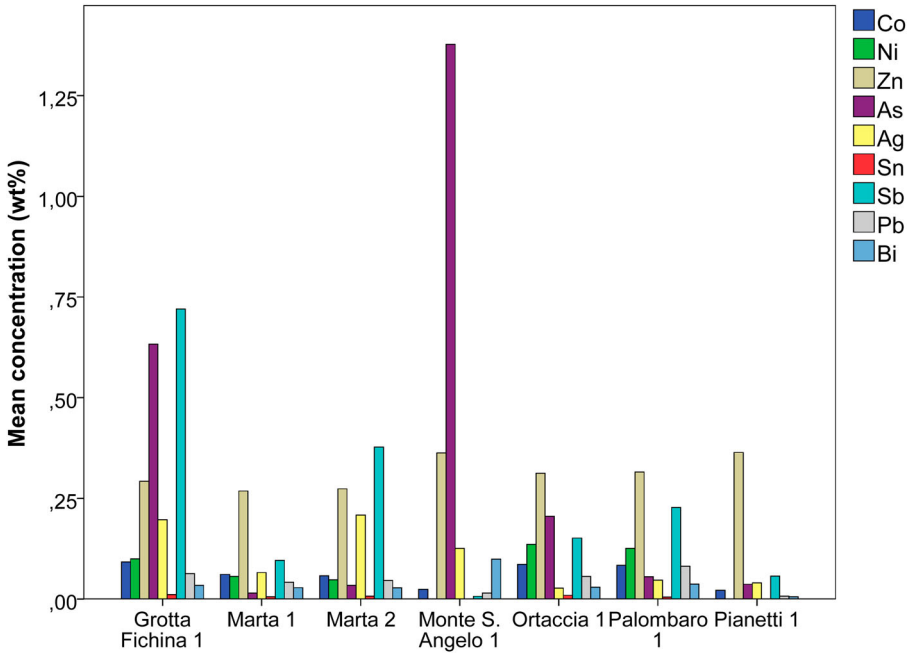

Figure 6. Compositional profiles of the Eneolithic axes; bars account for the mean concentration calculated over all the measurements performed on the single object.

The daggers Poggio Spolverino 1, Selvicciola necropolis 1 and Selvicciola necropolis 2 (see Appendix) are made of arsenical copper: the content of As is high, while Zn and Ag are low and comparable; two dagger blades from the northern area (Selvicciola necropolis 3 and Ortaccia 2) show significant amounts of As and Sb, which are supposedly due to the use of *fahlerz* minerals. The last dagger blade of the group (Poggio degli Spiriti 1) has a compositional profile completely different from the others and characterized by relatively high amounts of Ni, Ag, Sb and by low As. The latter item seems compositionally similar to artefacts from northern Italy, dated at the beginning of the Early Bronze Age, for which it was recognized the use of *fahlerz* minerals (De Marinis 2006).

Figure 4 shows that axes have low concentrations of As and Sb compared to daggers. In particular, from the compositional profiles of axes alone (Figure 6), it appears higher heterogeneity respect to the daggers (Figure 5): the use of *fahlerz* minerals for the axe Grotta Fichina 1 and of arsenical copper for the axe Monte S. Angelo 1 is recognizable. For the other artefacts, ore source is more uncertain. The Zn content is around the detection limit in all axes.

Awls, which are the most widely distributed items all over the Italian territory, at the moment do not provide significant information.

It is to be noted that the use of *fahlerz* minerals that we observe here in this period, does not occur in the Late Eneolithic in northern Italy (De Marinis 2006).

Bronze Age

In the investigated areas, metallic findings belonging to the initial phase of the Early Bronze Age are missing, opposite to what happens in northern Italy. Here, for the *facies* of Polada, an initial horizon is documented (Early Bronze Age IA) corresponding to the Middle-European phase A1 (De Marinis 2006). It is known that the copper used in this phase was smelted from *fahlerz* minerals, with high concentrations of As, Sb, Ag and Ni, whereas Sn, Pb, Bi, Fe at low or trace levels. The artefacts investigated in this work pertain to a chronologically and technologically more advanced phase of the Early Bronze Age when the use of binary Cu-Sn alloys was established. Figure 7, where the artefacts are presented in chronological order, shows that, for the Early Bronze Age, Sn concentrations reach a peak approximately corresponding to the so-called "horizon 3rd of the hoards", followed by a decrease extending to the whole Middle Bronze Age and by a new increase in the Late Bronze Age.

Further analysis of the data set shows that the compositional changes are correlated to chronology more than to geography, Zn, Ag and Pb being the most effective discriminators.

Figure 8 shows the Ag-Zn scatterplot, with different colors used to distinguish among different periods of the Bronze Age. It is observed that both Zn and Ag are below 1 wt%. The former is relatively high in the Early Bronze Age, then it tends to stabilize at lower levels. The latter tends to increase and reaches the highest levels in the Final Bronze Age.

Figure 9 shows thePb-Zn scatterplot for the Bronze Age artefacts. Both elements are relatively high in the Early Bronze Age and tend to decrease in later phases.

An anomalous presence of Fe, especially concentrated in the group of artefacts coming from lake Mezzano, is apparent. Such behavior might be explained, at

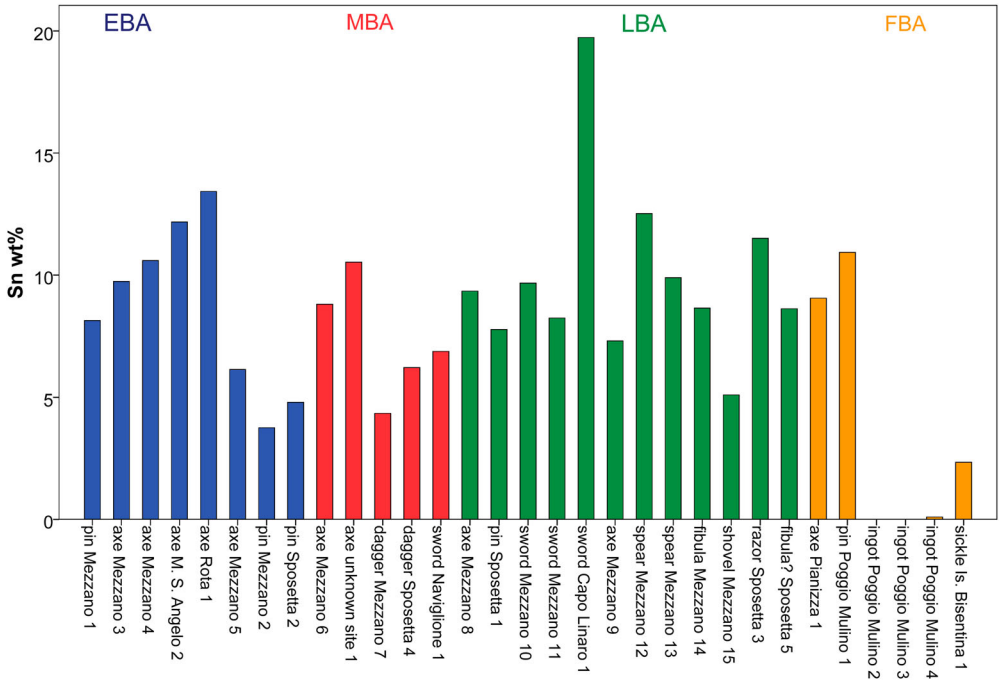

Figure 7. Bar-chart of the Sn mean concentration for the Bronze Age artefacts; blue, red, green and orange bars refer to the Early Bronze Age, Middle Bronze Age, Late Bronze Age and Final Bronze Age, respectively.

least in part, by assuming the use of slagging in the smelting process (Craddock and Meeks 1987; Garagnani, Spinedi, and Baffetti 1993). Figure 10 shows the bar-chart of Fe concentration for all the artefacts, including the Eneolithic and Early Iron Age ones. The increase in Fe content at the transition from Eneolithic to Early Bronze Age is consistent with Craddock and Meeks 1987 if one supposes that the use of slagging was introduced at that time. The question is complex since no slags or furnaces were found in the investigated areas.

The slagging process, however, does not explain the high (up to 20 wt%) and extremely variable Fe concentrations observed in some artefacts from Lake Mezzano, for which intentional Fe-Cu alloys cannot be excluded. Further research including microstructural analysis will be carried out to clear this point.

Finally, it might be necessary to consider the effect of the ferrous underwater sources present in Lake Mezzano, although surface iron deposits should have been removed when the artefact was prepared for analysis.

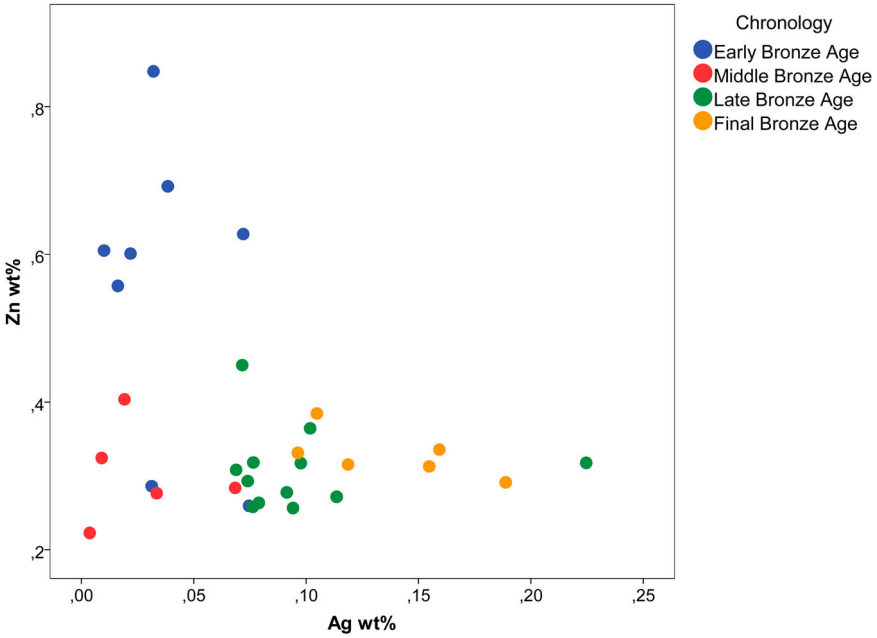

Figure 8. Ag-Zn scatterplot for the Bronze Age artefacts; blue, red, green and orange circles refer to the Early Bronze Age, Middle Bronze Age, Late Bronze Age and Final Bronze Age, respectively.

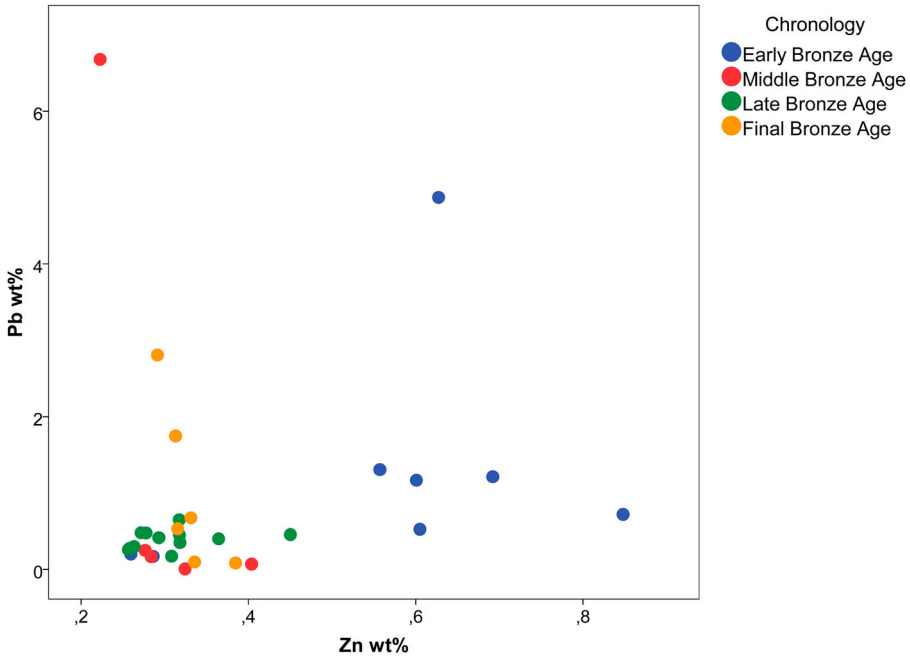

Figure 9. Pb-Zn scatterplot for the Bronze Age artefacts; blue, red, green and orange circles refer to the Early Bronze Age, Middle Bronze Age, Late Bronze Age and Final Bronze Age, respectively.

Early Iron Age

The Early Iron Age is a complex period on the Middle-Tyrrhenian side of the Italian peninsula. The historical processes that started in the Middle Bronze Age lead to complex urbanization phenomena. The production of metal objects was subjected to further increase, as proved by the grave goods found in the necropolises situated around the centers that, at the end of the VIIIth century B.C., became the Etruscan cities.

All the Early Iron Age artefacts are from the Selvicciola hoard. This hoard, accidentally discovered in 1957, was soon dispersed. F. Rittatore Vonwiller could recover and return to the Superintendence only a small part of it. The loss of information resulting from the incompleteness of the hoard is, even more, penalizing if one considers that several items have unusual compositions and need deeper investigation.

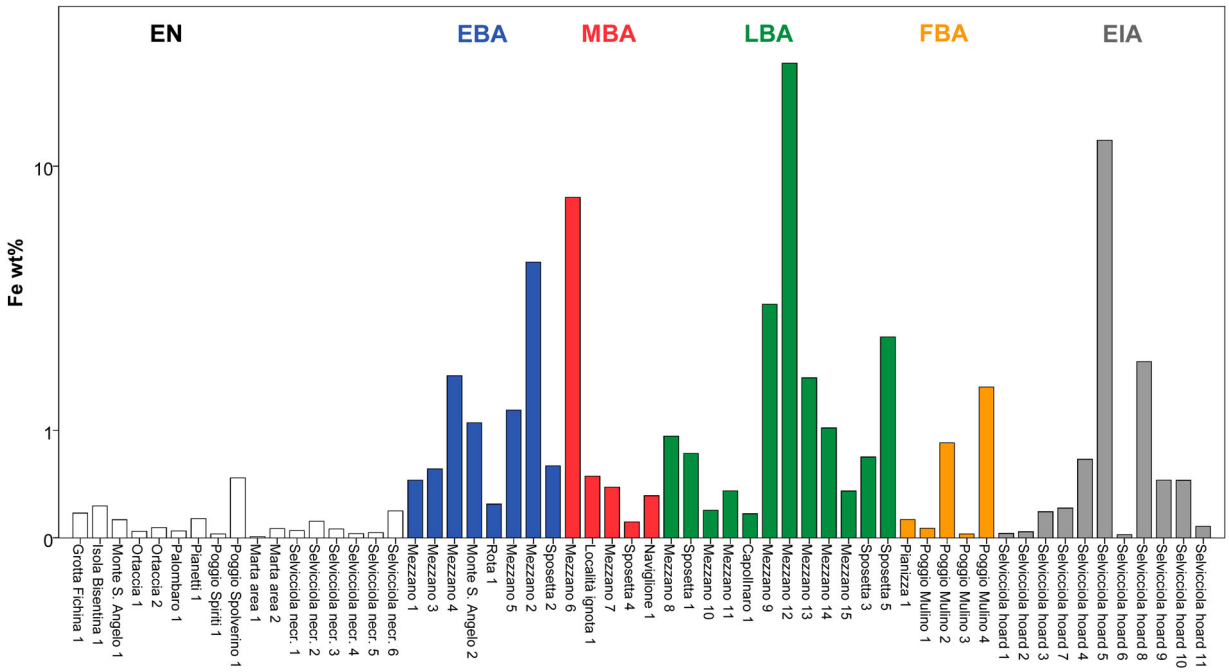

Figure 10. Bar-chart of the Fe mean concentration for all artefacts; a pseudo-logarithmic transform y = sign(x)*log(1 + abs(x)) is applied to the vertical axis to improve readability of low values; white, blue, red, green, orange and grey bars refer to Eneolithic, Early Bronze Age, Middle Bronze Age, Late Bronze Age, Final Bronze Age and Early Iron Age, respectively.

Table 2. Mutual correlation coefficients of the elements concentration.

	Fe wt%	Co wt%	Ni wt%	Cu wt%	Zn wt%	As wt%	Ag wt%	Sn wt%	Sb wt%	Pb wt%	Bi wt%
Fe wt%	1										
Co wt%	.241	1									
Ni wt%	−0.354	.717	1								
Cu wt%	−.724	−.553	−.141	1							
Zn wt%	−.566	−.477	−.165	.937	1						
As wt%	−.288	.512	.792	−.027	.073	1					
Ag wt%	−.305	.488	.790	−.007	.110	.941	1				
Sn wt%	−.147	−.567	−.604	.622	.626	−.482	−.552	1			
Sb wt%	−.286	.494	.819	−.041	.051	.959	.977	−.553	1		
Pb wt%	−.230	.281	.412	−.464	−.640	.126	.113	−.599	.138	1	
Bi wt%	−.386	.256	.428	−.268	−.463	.091	.088	−.347	.109	.898	1

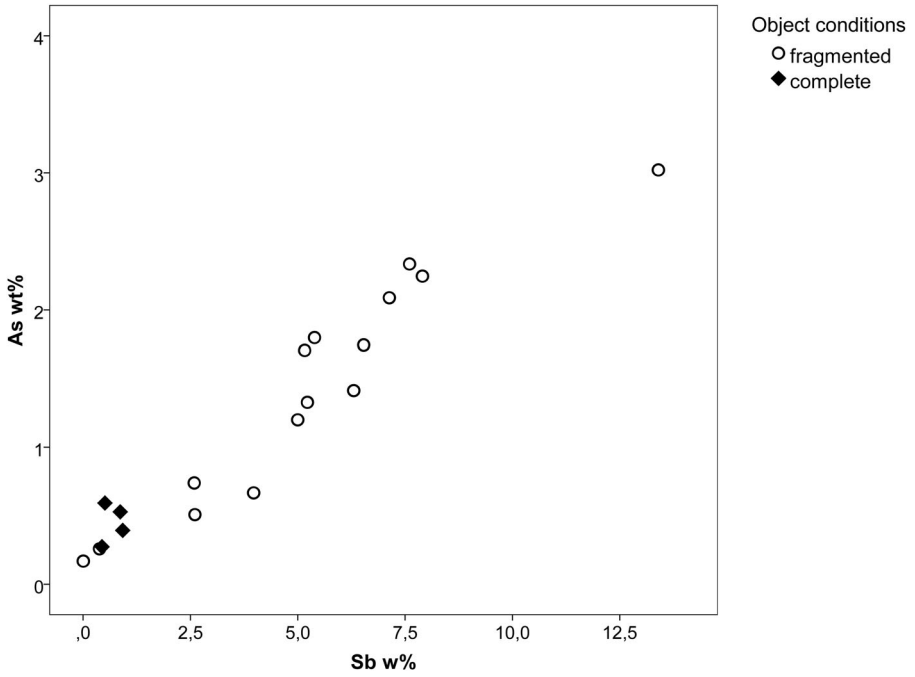

Figure 11. Sb-As scatterplot for the Early Iron Age artefacts; circles and diamonds refer to the fragmented and complete objects, respectively.

An important distinction concerns the conditions of the artefacts: few are complete, whereas the majority is fragmented. Their function, whether axe, ring, bracelet or ingot, is however recognizable.

Table 2 shows the mutual correlation coefficients of the elements concentration. It appears that some elements, i.e. Co, Ni, As, Ag and Sb, are positively correlated to one another, which leads assuming that they came into the alloy altogether in the (Sb-rich) ore. This point will be addressed further below. All these elements are low in the complete items and high in the fragmented ones. Figure 11 provides an example of the correlation for the pair Sb-As.

Another effective element to distinguish between the two groups is Zn, which is high in the complete items and low in the fragmented ones, as shown in Figure 12.

The most striking feature, however, are the elements intentionally alloyed with copper, provided one considers 1 wt% as the borderline of intentional addition. Figures 13–15 show the Sn-Sb, Sn-Pb and Sb-Pb scatterplots. In the complete artefacts, Cu is alloyed with Sn, whereas Sb and Pb are below 1 wt %. Conversely, in most fragmented objects Cu is alloyed with Sb and Pb (Sn is below 1 wt%), except two axe-blades, which contain Pb but no Sb and two fragments, which contain Sb, but no Pb.

The concentration of As, in the range of 1–2.5 wt%, is on the borderline of intentional addition. However, its correlation with Sb (Figure 11), which is assumed to be the intentional alloying element, leads to conclude that it was not deliberately added.

It appears that the elemental composition of the hoard items is strongly correlated to the conditions of the object, whether it is complete or fragmented. Taking into account the processes that lead to the formation of a hoard and given the chronological homogeneity of all the artefacts, it is clear that the observed compositional differences do not depend on chronology, nor on lack of metallurgical knowledge. The analysis of the characteristics of Early Iron Age societies, which in the Middle Tyrrhenian Italy of the 8th century B.C. are highly

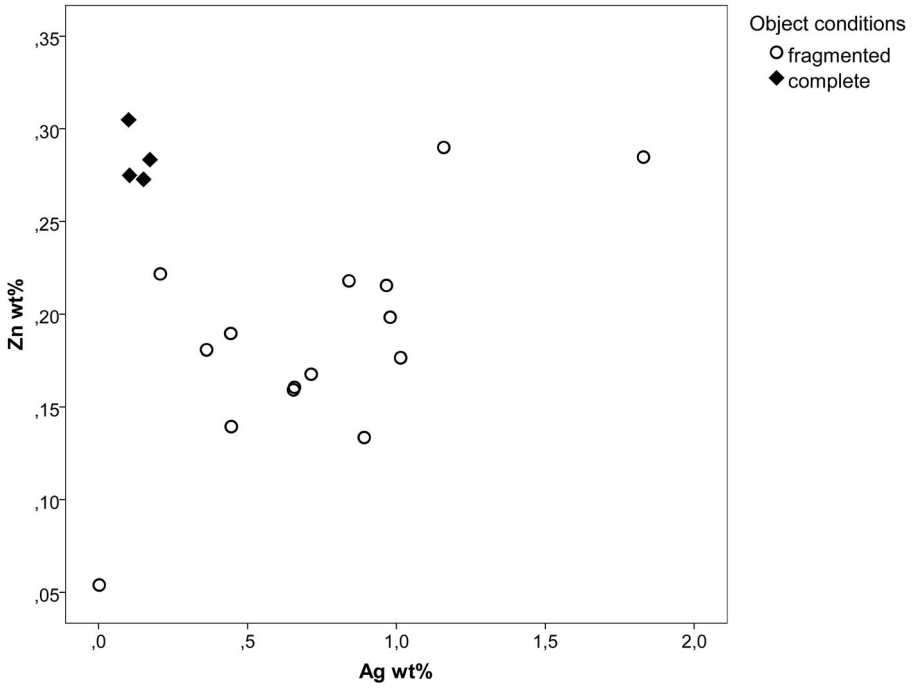

Figure 12. Ag-Zn scatterplot for the Early Iron Age artefacts; circles and diamonds refer to the fragmented and complete objects, respectively.

urbanized, brings us to suppose that such differences might be related to a diversified production system, capable of using alloys of different quality and value to meet a diversified demand.

Conclusions

As already pointed out, this paper aims at presenting the first outcomes of an ongoing project. At this stage, it is, therefore, more appropriate to formulate hypotheses than draw ultimate conclusions.

Concerning the Eneolithic, the analysis carried out on three different types of items, i.e. axes, daggers and awls, confirms what is known for the whole Italian peninsula, i.e. alloys of "*deliberate different composition*" were used for the production of axes and dagger blades (De Marinis 2006). In the case of daggers, the difference between copper rich in As and copper rich

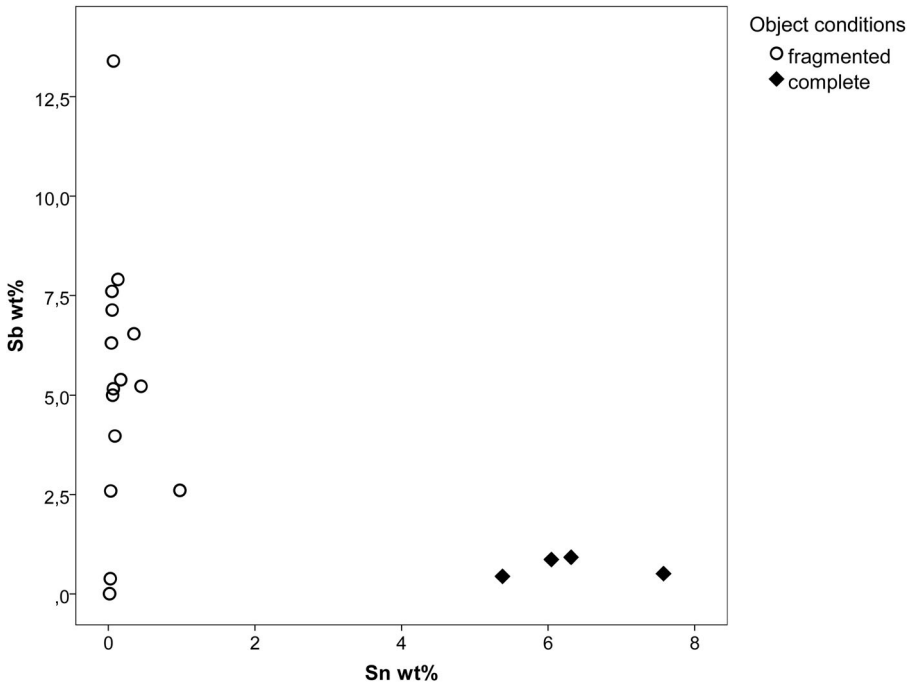

Figure 13. Sn-Sb scatterplot for the Early Iron Age artefacts; circles and diamonds refer to the fragmented and complete objects, respectively.

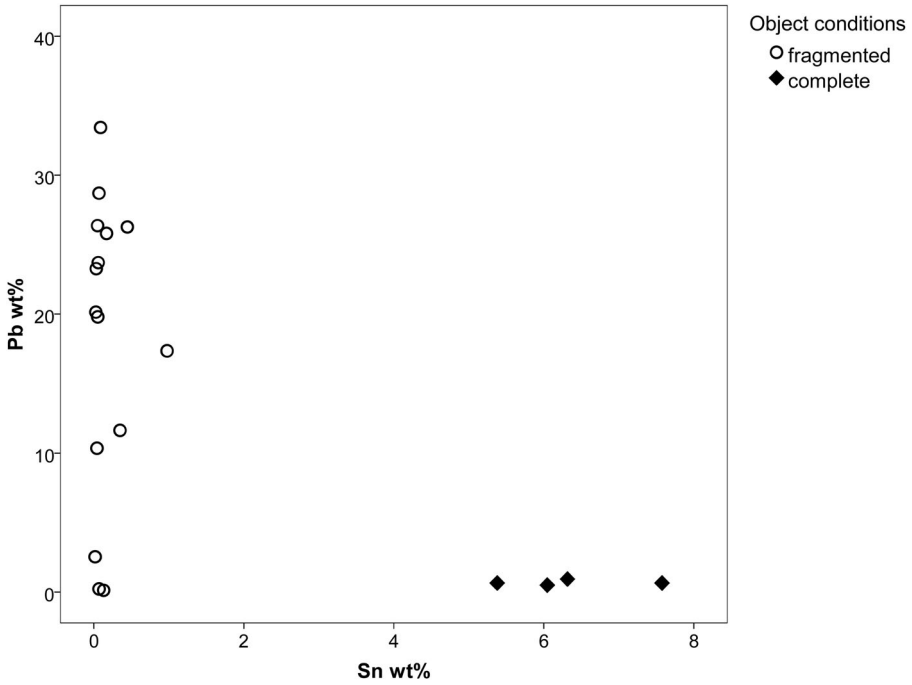

Figure 14. Sn-Pb scatterplot for the Early Iron Age artefacts; circles and diamonds refer to the fragmented and complete objects, respectively.

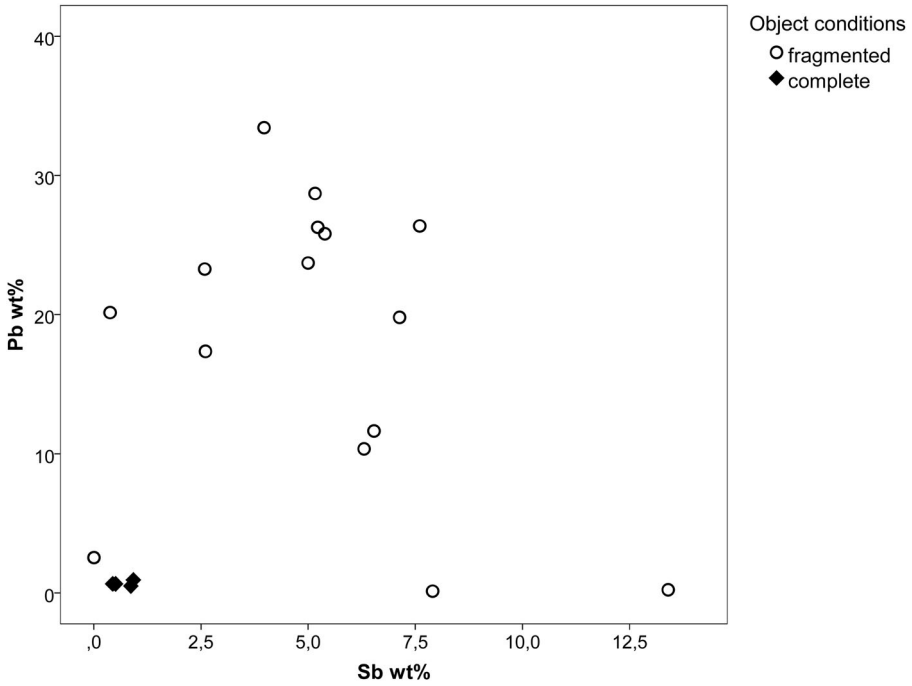

Figure 15. Sb-Pb scatterplot for the Early Iron Age artefacts; circles and diamonds refer to the fragmented and complete objects, respectively.

in both As and Sb is supposed to be connected to the chronological development of Eneolithic, namely to the beginning and to the advanced phase, respectively, of Central Italy Eneolithic. Indeed, this hypothesis may be affected by the formation process of an archaeological deposit inside a common burial (De Marinis 2006), from which most of the analysed artefacts come.

Compositional differences between axes and dagger blades are known to be part of the experimental character of Eneolithic metallurgy. Search for standardized solutions can explain the higher compositional variability of Eneolithic artefacts respect to Bronze Age ones.

An overall view of Eneolithic metallurgy requires to mention, besides the copper-based alloys discussed in this paper, Cu–Ag alloys as well as the frequent and documented use of Sb alone, in particular for ornaments. Whereas Sb artefacts are in general extremely

rare in the Italian and European settlements, they are relatively common in Central Tyrrhenian Italy, with special regard for the middle valley of River Fiora. Moreover, in the Italian Eneolithic, objects made of Cu–Ag alloys can be found. Another extraordinary finding is a fragment of an iron awl, discovered in tomb 21 of the Selvicciola necropolis. This find does not imply to backdate the beginning of iron metallurgy from the 1st to the 4th millennium B.C., but it documents a phase of alloying and process experiments (Grazzi et al. 2012).

Compared to Eneolithic, the Bronze Age shows an extraordinary increase consisting not only in larger numbers but also in new types of objects now made of metal.

Copper-based alloys have now reached a standard composition (at least from the qualitative point of view) involving the use of Sn as the main alloying element. Its concentration has relatively regular variations versus time. According to literature, it was not mined locally, therefore we hypothesize that such variations are due to corresponding variations in Sn availability.

Changes in the content of Ag, Zn, and Pb, all considered unintentional, are possibly related to changes in the smelting technology. Conversely, changes in ore supply are not likely since, for both the northern and the southern area, mineral sources were locally available (Tanelli 1985; Zifferero 1992).

Regarding the Early Iron Age, the data on the Selvicciola Hoard should be interpreted as resulting from a commercial strategy, rather than a technological regression. At the moment we have found no comparisons in the literature. In the case of S. Francesco hoard (Antonacci Sanpaolo, Canziani Ricci, and Follo 1992), for example, there seems to be no difference in composition between fragments and complete artefacts. Thus, at the present stage of the research, the results obtained for the Selvicciola hoard must be considered strictly limited to the area of Vulci.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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References

Angle, M., and L. D'Erme. 1995. "Ambiente e popolamento nel comprensorio vulsino tra il neolitico e la prima età del ferro." Atti del Secondo incontro di Studi PPE, Milano, 199–208.

Antonacci Sanpaolo, E., C. Canziani Ricci, and L. Follo. 1992. "Il deposito di S. Francesco (Bologna) ed il contributo delle indagini archeometallurgiche." Atti del Colloquio Internazionale di Archeometallurgia, Bologna, 159–206.

Aspes, A., ed. 2011. *I bronzi del Garda: valorizzazione delle collezioni di bronzi preistorici di uno dei più importanti centri metallurgici dell'Europa del II millennio a. C.* Verona: Memorie del Museo Civico di Storia Naturale di Verona, 2 serie, vol. 11.

Aspesi, M. 2012. "Le necropoli rinaldoniane del Palombaro e di Chiusa d'Ermini. Revisione degli scavi di Ferrante Ritttore Vonwiller." Atti del Decimo Incontro di Studi PPE, Milano, 223–245.

Bianco Peroni, V. 1994. *I pugnali nell'Italia continentale.* P.B.F. VI. Stuttgart: F. Steiner.

Biddittu, I., N. Bruni, G. L. Carancini, M. Cerqua, and A. Riva. 2007. "La frequentazione delle grotte di Pastena in età preistorica e protostorica." *Atti della XL Riunione Scientifica dell'IIPP* II vols, Firenze: 683–693.

Bietti Sestieri, A. M. 1973. "The Metal Industry of Continental Italy, 13th-11th Century, and its Aegean Connections." *Proceedings of the Prehistoric Society* 39: 383–424.

Carancini, G. L. 1979a. "I ripostigli dell'età del Bronzo finale." Atti della XXI Riunione Scientifica dell'IIPP, Firenze, 631–641.

Carancini, G. L. 1979b. "Alcuni aspetti della metallurgia nel Lazio nel corso dell'età del Bronzo." Archeologia Laziale II, Roma, 177–184.

Carancini, G. L. 1984. *Le asce nell'Italia continentale 2*. P.B.F. 12. Munchen: C. H. Beck.

Carancini, G. L. 1993. "Primi sviluppi della metallurgia nell'area medio-tirrenica nel quadro della protostoria peninsulare." In *Vulcano a Mezzano - Insediamento e produzioni artigianali nella media valle del Fiora durante l'età del bronzo*, 125–150. Viterbo: Comune di Valentano.

Carancini, G. L. 2001. "Origine e primi sviluppi della metallurgia in Toscana nell'ambito delle fasi più antiche della Protostoria." Atti della XXXIV Riunione Scientifica dell'IIPP, Firenze, 236–249.

Carancini, G. L., and R. Peroni. 1999. *L' età del bronzo in Italia: per una cronologia della produzione metallurgica*. Perugia: Ali&no.

China, F., A. M. Conti, and C. Persiani. 1993. "La tomba eneolitica di Grotta Fichina." Atti del Primo incontro di Studi, Milano, 197–198.

Craddock, P. T., and N. D. Meeks. 1987. "Iron in Ancient Copper." *Archaeometry* 29 (2): 187–204.

Damiani, I., P. Petitti, and F. Trucco. 2008. "L'insediamento sommerso di Sposetta." In *AES. Metalli preistorici dalla Tuscia*, edited by Patrizia Petitti and Fabio Rossi, 28–31. Grotte di Castro: Comune di Valentano.

De Marinis, R. C. 2006. "Aspetti della metallurgia dell'età del Rame e dell'antica età del Bronzo nella penisola italiana." *Rivista di Scienze Preistoriche* LVI: 211–272.

Dolfini, A., and C. Giardino. 2015. "L'archeometallurgia preistorica nel Mediterraneo centrale. Bilanci e programmi agli inizi del XXI secolo." *Studi di Antichità* 13, nuova serie, Galatina (Lecce): 141–174.

Enei, F. 2014. "Una spada dell'età del bronzo dal fondale di Capo Linaro a Santa Marinella (Roma – Italia)." *Archaeologia Maritima Mediterranea* XI: 49–51.

Falchetti, F. 1982. "Due nuove necropoli eneolitiche della cultura di Rinaldone nella valle del Fiora." In *Studi in onore di Ferrante Rittatore Vonwiller*, 135–143. Como: G. Malinverno.

Ferretti, M. 2014. "The Investigation of Ancient Metal Artefacts by Portable X-ray Fluorescence Devices." *Journal of Analytical Atomic Spectrometry* 29: 1753–1766.

Fugazzola Delpino, M. A. 1982. "La preistoria e la Protostoria nell'Etruria Meridionale: nota preliminare su alcune scoperte degli ultimi anni." Archeologia nella Tuscia. Primo incontro di studio, Roma, 76–94.

Garagnani, G. L., P. Spinedi, and A. Baffetti. 1993. "Caratterizzazione microstrutturale ed analisi chimiche dei reperti metallici." In *Vulcano a Mezzano. Insediamento e produzione artigianale nella media valle del Fiora durante l'età del Bronzo*, 87–95. Viterbo: Comune di Valentano.

Giardino, C., G. Occhini, P. Petitti, and D. Steiniger. 2014. "Ricerche archeominerarie in Etruria Meridionale." Atti dell'Undicesimo incontro di Studi PPE, Milano, 653–666.

Grazzi, F., P. Pallecchi, P. Petitti, A. Scherillo, and M. Zoppi. 2012. "Non-invasive Quantitative Phase Analysis and Microstructural Properties of an Iron Fragment Retrieved in the Copper-age Selvicciola Necropolis in Southern Tuscia." *Journal of Analytical Atomic Spectrometry* 27: 293–298.

Jenkins, R., R. W. Gould, and D. Gedke. 1995. *Quantitative X-ray Spectrometry*. 2nd ed. New York: Marcel Dekker Inc, 402.

Junghans, S., E. Sangmeister, and M. Schröder. 1960. *Metallanalysen kupferzeitlicher und frühbronzezeitlicher Bodenfunde aus Europa*. Berlin: Studien zu den Anfängen der Metallurgie, Band 1.

Junghans, S., E. Sangmeister, and M. Schröder. 1968. "Kupfer und Bronze in der frühen Metallzeit Europas." Studien zu den Anfängen der Metallurgie, Band 2, Teil 1-3, Berlin.

Junghans, S., E. Sangmeister, and M. Schröder. 1974. "Kupfer und Bronze in der frühen Metallzeit Europas." Studien zu den Anfängen der Metallurgie, Band 2, Teil 4, Berlin.

Negroni Catacchio, N. 1981. "15. Pianizza (Ischia di Castro – Viterbo)." In *Sorgenti della Nova. Una comunità protostorica e il suo territorio nell'Etruria Meridionale*, edited by Nuccia Negroni Catacchio, 386–387. Roma: C.N.R.

Otto, H., and W. Witter. 1952. *Handbuch der ältesten vorgeschichtlichen Metallurgie in Mitteleuropa*. Lipsia: Johann Ambrosius Bart.

Pellegrini, E. 1993. "Aspetti della metallurgia nel comprensorio del Lago di Mezzano e nella media valle del Fiora dal Bronzo Antico all'XI secolo a.C." In *Vulcano a Mezzano - Insediamento e produzioni artigianali nella media valle del Fiora durante l'età del bronzo*, 73–85. Viterbo: Comune di Valentano.

Petitti, P. 2000. "La Caldera di Latera: appunti su materiali di nuova scoperta e contatti a lunga distanza." Atti del Quarto incontro di Studi PPE, Milano, 141–149.

Petitti, P., A. Benini, I. Reindell, M. L. Santarelli, E. Severi, D. Silenzi, and G. Tei. 2009. "Le Piroghe monossili del Lago di Bolsena." In *Sul filo della corrente. La navigazione nelle acque interne in Italia centrale dalla preistoria all'età moderna*, edited by Patrizia Petitti, 9–38. Montefiascone: Comune di Capodimonte.

Petitti, P., C. Persiani, and P. Pallecchi. 2011. "Reperti metallici dalla necropoli della Selvicciola (Ischia di Castro-Viterbo)." Atti della XLIII Riunione Scientifica, Firenze, 187–194.

Petitti, P., and F. Rossi. 2008. "L'ipogeo "R" della necropoli del Naviglione (Farnese, VT)." In *AES. Metalli preistorici dalla Tuscia*, 21–27. Grotte di Castro: Comune di Valentano.

Rossi, F. 2008a. "L'attività metallurgica nell'insediamento del Lago di Mezzano: nuovi elementi." In *AES. Metalli preistorici dalla Tuscia*, edited by Patrizia Petitti and Fabio Rossi, 15–16. Grotte di Castro: Comune di Valentano.

Rossi, F. 2008b. "Il Ripostiglio della Selvicciola." In *AES. Metalli preistorici dalla Tuscia*, edited by Patrizia Petitti and Fabio Rossi, 40–42. Grotte di Castro: Comune di Valentano.

Rossi, F. 2012. "67-Poggi del Mulino-Casale Moscini." In *Preistoria di un paesaggio. La Caldera di Latera e il territorio circostante*, edited by Patrizia Petitti and Fabio Rossi, 91–92. Bolsena: Città di Bolsena Editrice.

Solé, V. A., E. Papillon, M. Cotte, P. Walter, and J. Susini. 2007. "A Multiplatform Code for the Analysis of Energy-Dispersive X-ray Fluorescence Spectra." *Spectrochimica Acta B* 62: 63–68.

Tanelli, G. 1985. "I depositi metalliferi dell'Etruria e le attività estrattive degli Etruschi." In *Atti del II Congresso Internazionale di Studi Etruschi, supplemento a Studi Etruschi III*, 1409–1417. Roma: G. Bretschneider.

Toti, O. 1973. "Alcune testimonianze dell'età del Bronzo antico." *Notiziario del Museo di Allumiere* 2: 67–69.

Zifferero, A. 1992. "Giacimenti minerari e insediamento nel Lazio settentrionale: recenti acquisizioni e prospettive di ricerca." In *Archeometallurgia. Ricerche e prospettive*, edited by Elena Antonacci Sanpaolo, 81–103. Bologna: Atti del Colloquio Internazionale di Archeometallurgia.

Appendix: Catalogue of the analyzed findings

Northern area

Grotta Fichina (Monte Romano, Viterbo); rock-cut tomb; Museo della Preistoria della Tuscia e della Rocca Farnese (Valentano, Viterbo)
Dating: Eneolithic
Reference: China, Conti, and Persiani 1993

(1) Flat axe similar to Siena and Santa Cristina types (Carancini 1993, fig 2, n 23, letter D)

La Selvicciola (Ischia di Castro, Viterbo): rock-cut tombs necropolis; Museo della Preistoria della Tuscia e della Rocca Farnese (Valentano, Viterbo)
Dating: Eneolithic (from half 4th millennium to last centuries of the 3rd millennium)
Reference: Petitti, Persiani, and Pallecchi 2011

(1) Dagger blade from tomb 15: probably it is an autonomous type; in association to a primary deposition, dated 2891-2617 B.C. (C14 analysis);
(2) Blade perhaps of a dagger from tomb 14: it is not clear to which deposition was associated, the lower one dated 3331-2668 B.C. (C14 analysis), or the upper one 2275-1931 B.C. (C14 analysis);
(3) Dagger blade complete with two rivets from tomb 34, similar to Massa Marittima type; based on a typological comparison it can be ascribed to the centuries at the end of the 4th and the beginning of the 3rd millennium B.C.;
(4) Awl from tomb 2; in association to human remains in a secondary deposition, dated 2472-2007 B.C. (C14 analysis) and 3097-2464 B.C. (C14 analysis)
(5) Awl from tomb 6; in association to a primary deposition dated 3095-2878 B.C. (C14 analysis);
(6) Awl from tomb 36.

La Selvicciola (Ischia di Castro, Viterbo): hoard; Museo della Preistoria della Tuscia e della Rocca Farnese (Valentano, Viterbo)
Dating: Early Iron Age
Reference: Rossi 2008b

(1) San Francesco type winged axe, variety B, dated back to the second half of the 8th century B.C. (Carancini 1984, tav. 85–88);
(2) Winged axe; dated back to the half of the 8th century B.C. (Carancini 1984, tav. 8–11);
(3) Vetulonia type winged axe; dated back to the second half of the 9th century B.C. (Carancini 1984, tav. 1–4);
(4) 4 fragments of winged axe, not definable;
(5) 6 fragments of axe blade;
(6) Fragmented axe wing;
(7) Gouge-awl;
(8) Fragment of a ring with circular section;
(9) Fragment of a bracelet with rhomboidal section;
(10) Ingot fragment with flat-convex section;
(11) Ingot fragment with trapezoidal section.

Lake Bolsena near Punta Calcino, Bisentina Island (Capodimonte, Viterbo); logboat wreckage; Museo della Preistoria della Tuscia e della Rocca Farnese (Valentano, Viterbo)
Dating: Final Bronze Age
Reference: Petitti et al. 2009, 22, fig. 12

(1) Sickle similar to the Poggio Berni type, second-third horizon of the Final Bronze Age hoards (Carancini 1979a, 635, fig. 2, 20; Carancini and Peroni 1999, tav. 32).

Lake Mezzano (Valentano, Viterbo); submerged settlement; Museo della Preistoria della Tuscia e della Rocca Farnese (Valentano, Viterbo)
Dating: from Early Bronze Age (2300 B.C.) to Late Bronze Age (1300 B.C.)
Reference: Pellegrini 1993; Petitti 2000; Rossi 2008a

(1) Pin with disk head, second/third horizon of Early Bronze Age hoards;
(2) Pin with three spirals head and spur dated back to the final phase of Early Bronze Age;
(3) Amelia type axe, second and/or third horizon of the Early Bronze Age hoards;
(4) Cetinale type axe, third horizon of the Early Bronze Age hoards;
(5) Raised edges axe, late third /forth horizon of the Early Bronze Age hoards;
(6) Canterano type axe, attributed to the Middle Bronze Age 1;
(7) Gualdo Tadino type dagger (Bianco Peroni 1994, 65–66, tav. 34, 479), dated back to Middle Bronze Age 2;
(8) Winged axe, dated back to the early phase of the Late Bronze Age;
(9) Average wing-shaped axe, similar to Pertosa type, dated back to the final phase of Late Bronze Age;
(10) Arco type tang sword dated back to the Late Bronze Age;
(11) Canegrate type tang sword dated back to the Late Bronze Age;
(12) Spear with two little pronged instead of the fixing hols, dated back to the final phase of Late Bronze Age;
(13) Spear dated back to the Late Bronze Age;
(14) Violin arc foliated fibula dated back to the final phase of Late Bronze Age;
(15) Small shovel with large tang, dated back to the final phase of Late Bronze Age.

Naviglione (Farnese, Viterbo); ipogeum R; Museo della Preistoria della Tuscia e della Rocca Farnese (Valentano, Viterbo)
Dating: Middle Bronze Age
Reference: Petitti, and Rossi 2008

(1) Pertosa type sword, dated back to the final phase of the Middle Bronze Age.

Ortaccia (Ischia di Castro, Viterbo); rock-cut tombs necropolis, tomb n. 4; Museo della Preistoria della Tuscia e della Rocca Farnese (Valentano, Viterbo)
Dating: Eneolithic
Reference: Falchetti 1982

(1) Flat axe badly preserved, similar to Pianetti-Kollmann type (Carancini 2001, 240–241, fig2A);
(2) Vecchiano type dagger blade (Bianco Peroni 1994, 9).

Palombaro (Farnese, Viterbo); rock-cut tombs necropolis, sporadic materials; Museo della Preistoria della Tuscia e della Rocca Farnese (Valentano, Viterbo)
Dating: Eneolithic
Reference: Aspesi 2012

(1) Naviglione type flat axe (Carancini 1993, fig 2, n. 18)

Pianetti (Ischia di Castro, Viterbo); isolated object; Museo Civico "F. Rittatore Vonwiller" (Farnese, Viterbo)
Dating: Eneolithic
Reference: unpublished

(1) Flat axe, the altered surfaces do not allow to identify the typology of the finding.

Pianizza (Ischia di Castro, Viterbo); isolated object (hoard?); Museo della Preistoria della Tuscia e della Rocca Farnese (Valentano, Viterbo)
Dating: Final Bronze Age
Reference: Negroni Catacchio 1981, 387, tav. 103, E1

(1) Casalecchio type winged axe (Bietti Sestieri 1973), dated back to the Final Bronze Age.

Poggi del Mulino-Casale Moscini (Valentano, Viterbo); surface collection; Museo della Preistoria della Tuscia e della Rocca Farnese (Valentano, Viterbo)
Dating: Final Bronze Age
Reference: Rossi 2012

(1) Complete pin with biconical end round off on the top;
(2) Small ingot fragment;
(3) Small ingot fragment;
(4) Small ingot fragment.

Marta's area (Marta, Viterbo); isolated object; Biblioteca di Marta (Viterbo)
Dating: Eneolithic
Reference: Angle and D'Erme 1995

(1) Bibbona type flat axe (Angle and D'Erme 1995, fig. 3, 1; Carancini 1993, fig 2, 13);
(2) Flax axe similar to Naviglione type (Angle and D'Erme 1995 fig 3, 2; Carancini 1993, fig 2, 18).

Southern area

Lake Bracciano near to Sposetta (Bracciano, Roma); submerged settlement; Museo della Preistoria della Tuscia e della Rocca Farnese (Valentano, Viterbo)
Dating: from Early to Late Bronze Age
Reference: Damiani, Petitti, and Trucco 2008

(1) S. Caterina or Bacino Marina type pin, incomplete, dated back to the Late Bronze Age;
(2) Pin with cruciform pinhead and ring ended dated back to the Early Bronze Age;
(3) Narrow blade two sides cutting razor, with two rivets in place, similar to Peschiera type, dated back to the Late Bronze Age.
(4) S. Ambrogio type dagger blade dated back to the Middle Bronze Age 2;
(5) Pin of *fibula* (?).

Monte S. Angelo (Allumiere, Roma); isolated object; Museo Civico Archeologico Naturalistico "Adolfo Klitsche de la Grange" (Allumiere, Roma)
(1) Dating: Eneolithic
Reference: Giardino et al. 2014
Mirabella Eclano type axe, on based on of a comparison it is dated back to the first half of the 3rd millennium.
(2) Dating: Early Bronze Age
Reference: Toti 1973, 67, tav IV, 1; Carancini 1979b, 177, fig 1, 18

(1) Vetulonia type axe, variant B, dated back to the third horizon of the hoards of the Early Bronze Age (Carancini 1993, 139, n 38 e fig 6, 38B; Carancini and Peroni 1999, tav 2)

Poggio degli Spiriti (Allumiere, Roma); isolated object; Museo civico archeologico naturalistico "Adolfo Klitsche de la Grange" (Allumiere, Roma)
Dating: Eneolithic
Reference: Giardino et al. 2014

(1) Dagger blade similar to Massa Marittima type (Bianco Peroni 1994, 19–21).

Poggio Spolverino (Santa Marinella, Roma); isolated object; Museo civico archeologico naturalistico "Adolfo Klitsche de la Grange" (Allumiere, Roma)
Dating: Eneolithic
Reference: Giardino et al. 2014

(1) Dagger blade with trapezoidal pierced tang. Comparing typologies it is dated 2nd half of 4th millennium B.C.

Rota (Tolfa, Roma); isolated object (hoard?); Museo civico archeologico naturalistico "Adolfo Klitsche de la Grange" (Allumiere, Roma)
Dating: Early Bronze Age
Reference: Fugazzola Delpino 1982

(1) Campiglia D'Orcia type raised edge axe (Carancini 1993, type 9, 137, fig 5 n. 9); dated back to the third horizon of the hoards of the Early Bronze Age (Carancini and Peroni 1999);

Sea depth near to Capo Linaro (S. Marinella, Roma); isolated object; Antiquarium di Pyrgi (S. Severa, S. Marinella, Roma)
Dating: Late Bronze Age
Reference: Enei 2014

(1) Arco type tang sword.

Unknown place; isolated object; Museo Civico Archeologico Naturalistico "Adolfo Klitsche de la Grange" (Allumiere, Roma)
Dating: Middle Bronze Age
Reference: unpublished

(1) Sezze type axe dated back to an early period of the Middle Bronze Age (Biddittu et al. 2007)

Table A1. Results of the analyses.

Object ID	Type	Conditions	Chronology	Fe (wt%)	Co (wt%)	Ni (wt%)	Cu (wt%)	Zn (wt%)	As (wt%)	Ag (wt%)	Sn (wt%)	Sb (wt%)	Pb (wt%)	Bi (wt%)
Grotta Fichina 01	axe	complete	EN	0.057	0.085	0.103	98.3	0.297	0.529	0.147	0.005	0.507	0.053	0.038
				0.179	0.097	0.117	98.1	0.288	0.512	0.201	0.008	0.549	0.064	0.030
				0.285	0.094	0.079	97.0	0.291	0.858	0.242	0.019	1.104	0.072	0.034
Marta area 01	axe	complete	EN	0.015	0.070	0.042	98.8	0.270	0.041	0.241	0.007	0.462	0.046	0.025
				0.000	0.052	0.076	99.6	0.274	0.012	0.028	0.007	0.004	0.033	0.027
				0.016	0.069	0.043	99.6	0.267	0.015	0.015	0.002	0.006	0.040	0.034
				0.003	0.058	0.054	99.6	0.269	0.001	0.021	0.004	0.004	0.046	0.028
				0.008	0.057	0.065	99.6	0.262	0.004	0.024	0.008	0.004	0.041	0.027
Marta area 02	axe	complete	EN	0.155	0.066	0.028	98.8	0.283	0.030	0.233	0.013	0.390	0.037	0.026
				0.014	0.063	0.046	98.9	0.280	0.018	0.221	0.004	0.465	0.058	0.024
				0.016	0.044	0.070	99.1	0.258	0.055	0.171	0.005	0.277	0.043	0.034
Monte S. Angelo 01	axe	complete	EN	0.114	0.025	0.000	98.3	0.356	1.110	0.120	0.000	0.007	0.015	0.062
				0.050	0.025	0.000	98.4	0.359	1.040	0.127	0.000	0.006	0.010	0.078
				0.208	0.023	0.000	97.3	0.374	1.982	0.131	0.002	0.007	0.019	0.157
Ortaccia 01	axe	complete	EN	0.044	0.086	0.136	99.1	0.313	0.205	0.027	0.009	0.151	0.056	0.029
Ortaccia 02	dagger	complete	EN	0.062	0.080	0.166	94.7	0.303	2.779	0.256	0.013	1.695	0.082	0.046
				0.076	0.122	0.142	92.5	0.301	4.462	0.337	0.010	2.039	0.138	0.015
Palombaro 01	axe	complete	EN	0.048	0.089	0.131	99.2	0.290	0.063	0.041	0.010	0.232	0.056	0.047
				0.043	0.071	0.139	99.1	0.328	0.056	0.053	0.003	0.218	0.084	0.035
				0.047	0.092	0.108	99.1	0.329	0.046	0.046	0.002	0.233	0.104	0.028
Pianetti 01	axe	complete	EN	0.238	0.018	0.000	99.2	0.367	0.044	0.040	0.000	0.060	0.008	0.007
				0.028	0.025	0.000	99.5	0.361	0.029	0.041	0.001	0.053	0.006	0.005
Poggio degli Spiriti 01	dagger	complete	EN	0.034	0.083	2.087	94.0	0.292	1.027	1.843	0.012	2.725	0.016	0.010
				0.018	0.089	2.921	95.1	0.289	0.973	1.267	0.009	2.358	0.005	0.003
Poggio Spolverino 01	dagger	complete	EN	0.472	0.021	0.000	93.2	0.337	5.868	0.100	0.002	0.004	0.011	0.016
				0.473	0.019	0.000	95.7	0.348	3.307	0.112	0.008	0.005	0.014	0.031
Selvicciola necropolis 01	dagger	complete	EN	0.065	0.094	0.113	97.0	0.323	2.392	0.084	0.009	0.007	0.022	0.106
				0.036	0.070	0.111	96.9	0.303	2.530	0.089	0.002	0.011	0.048	0.211
				0.034	0.081	0.067	95.8	0.287	3.678	0.087	0.008	0.011	0.012	0.169
				0.059	0.110	0.096	96.6	0.296	2.747	0.092	0.003	0.013	0.044	0.149
Selvicciola necropolis 02	dagger	complete	EN	0.082	0.060	0.190	96.2	0.317	3.009	0.086	0.006	0.025	0.234	0.019
				0.166	0.074	0.129	95.0	0.275	4.198	0.116	0.005	0.016	0.166	0.012
				0.091	0.085	0.148	95.8	0.320	3.359	0.106	0.002	0.020	0.185	0.034
Selvicciola necropolis 03	dagger	complete	EN	0.071	0.084	0.235	92.8	0.277	5.029	0.141	0.031	1.526	0.040	0.016
				0.039	0.083	0.322	90.7	0.260	6.674	0.150	0.016	1.913	0.109	0.014
				0.069	0.122	0.207	92.7	0.318	4.312	0.128	0.014	2.117	0.143	0.010
Selvicciola necropolis 04	awl	complete	EN	0.028	0.034	0.000	99.5	0.330	0.010	0.034	0.002	0.020	0.016	0.011
Selvicciola necropolis 05	awl	complete	EN	0.034	0.029	0.000	99.3	0.317	0.030	0.041	0.003	0.174	0.102	0.011
Selvicciola necropolis 06	awl	complete	EN	0.285	0.024	0.000	92.6	0.317	5.146	0.076	0.016	1.207	0.307	0.003
				0.097	0.020	0.000	96.1	0.317	2.009	0.089	0.011	1.075	0.317	0.006
Mezzano 01	pin	complete	EBA	0.287	0.125	0.073	90.0	0.565	0.247	0.025	7.497	0.104	1.162	0.065
				0.281	0.114	0.088	89.6	0.589	0.314	0.026	7.809	0.104	1.149	0.044
				0.551	0.120	0.101	89.1	0.617	0.303	0.023	8.113	0.123	1.085	0.015
				0.686	0.164	0.163	87.4	0.633	0.371	0.014	9.117	0.338	1.275	0.109
Mezzano 02	pin	complete	EBA	8.356	0.062	0.211	86.9	0.252	0.289	0.027	4.033	0.061	0.104	0.037
				15.030	0.054	0.156	79.8	0.270	0.335	0.031	4.336	0.055	0.169	0.008
				1.520	0.139	0.369	94.4	0.251	0.092	0.025	3.440	0.053	0.104	0.048

(*Continued*)

Table A1. Continued.

Object ID	Type	Conditions	Chronology	Fe (wt%)	Co (wt%)	Ni (wt%)	Cu (wt%)	Zn (wt%)	As (wt%)	Ag (wt%)	Sn (wt%)	Sb (wt%)	Pb (wt%)	Bi (wt%)
				10.590	0.066	0.222	85.0	0.262	0.283	0.027	3.690	0.056	0.190	0.017
				18.070	0.086	0.211	78.6	0.237	0.245	0.019	3.171	0.045	0.116	0.043
				0.778	0.139	0.413	93.9	0.250	0.109	0.041	4.266	0.111	0.401	0.204
				0.562	0.064	0.409	94.5	0.212	0.031	0.036	4.089	0.066	0.455	0.104
				4.318	0.031	0.172	91.0	0.339	0.221	0.035	3.964	0.062	0.077	0.018
				0.909	0.029	0.198	94.8	0.338	0.138	0.033	3.643	0.061	0.101	0.011
				1.072	0.028	0.183	94.4	0.339	0.160	0.034	3.817	0.066	0.098	0.009
				0.085	0.037	0.225	95.9	0.310	0.091	0.031	3.367	0.064	0.145	0.010
				0.433	0.028	0.223	95.5	0.311	0.124	0.034	3.389	0.067	0.152	0.018
				2.264	0.030	0.226	93.4	0.348	0.161	0.033	3.639	0.062	0.096	0.012
Mezzano 03	axe	complete	EBA	0.864	0.107	0.050	86.9	0.896	0.326	0.028	9.970	0.100	0.725	0.046
				0.151	0.150	0.081	88.0	0.756	0.260	0.029	9.494	0.089	0.865	0.077
				0.880	0.110	0.092	87.3	0.773	0.320	0.035	9.895	0.090	0.501	0.070
				0.324	0.164	0.056	87.6	0.880	0.222	0.037	9.549	0.110	0.902	0.052
				0.590	0.107	0.053	87.7	0.935	0.206	0.032	9.773	0.099	0.606	0.069
Mezzano 04	axe	complete	EBA	1.435	0.128	0.115	86.2	0.764	0.311	0.040	10.160	0.146	0.940	0.085
				3.597	0.082	0.138	83.5	0.611	0.442	0.041	10.290	0.135	1.372	0.076
				1.112	0.113	0.050	85.0	0.773	0.550	0.035	10.820	0.134	1.486	0.066
				1.025	0.102	0.056	85.6	0.698	0.526	0.037	10.630	0.140	1.268	0.051
				2.065	0.121	0.150	84.6	0.616	0.389	0.038	11.070	0.141	1.004	0.086
Mezzano 05	axe	complete	EBA	0.440	0.085	0.137	90.9	0.571	0.269	0.023	5.987	0.062	1.644	0.035
				0.404	0.092	0.098	90.7	0.589	0.288	0.010	6.120	0.061	1.798	0.055
				2.290	0.096	0.105	89.8	0.477	0.311	0.014	5.858	0.051	0.947	0.020
				1.760	0.090	0.075	89.6	0.553	0.315	0.024	6.307	0.048	1.278	0.030
				1.511	0.089	0.117	90.1	0.595	0.324	0.011	6.459	0.055	0.868	0.049
Monte S. Angelo 02	axe	complete	EBA	1.410	0.027	0.332	82.0	0.626	0.562	0.013	14.720	0.014	0.732	0.023
				1.016	0.037	0.214	85.8	0.619	0.439	0.009	11.570	0.014	0.513	0.015
				0.941	0.031	0.207	86.5	0.603	0.411	0.009	11.110	0.011	0.399	0.014
				1.039	0.031	0.188	86.2	0.572	0.414	0.010	11.290	0.012	0.455	0.013
Rota 01	axe	complete	EBA	0.150	0.033	0.209	84.7	0.627	0.737	0.058	10.990	0.146	2.548	0.103
				0.463	0.037	0.494	70.5	0.575	1.260	0.113	19.670	0.217	7.182	0.182
				0.143	0.033	0.190	85.2	0.687	0.698	0.050	9.839	0.127	3.303	0.105
				0.220	0.020	0.271	78.2	0.621	1.008	0.068	13.210	0.167	6.450	0.156
Sposetta 02	pin	complete	EBA	0.552	0.090	0.202	93.4	0.241	0.219	0.076	5.051	0.110	0.204	0.034
				0.647	0.094	0.203	93.6	0.254	0.160	0.074	4.882	0.117	0.204	0.043
				0.579	0.095	0.216	94.0	0.283	0.165	0.073	4.472	0.108	0.195	0.050
Mezzano 06	axe	complete	MBA	0.258	0.081	0.230	94.7	0.298	0.085	0.070	4.224	0.081	0.187	0.038
				0.534	0.115	0.223	94.2	0.283	0.170	0.066	4.399	0.084	0.137	0.034
				0.720	0.102	0.231	93.8	0.291	0.133	0.072	4.609	0.100	0.143	0.027
				0.251	0.068	0.256	94.5	0.271	0.082	0.069	4.493	0.102	0.180	0.061
				0.171	0.089	0.197	95.0	0.276	0.120	0.065	4.009	0.078	0.185	0.012
Mezzano 07	dagger	complete	MBA	0.258	0.081	0.230	94.7	0.298	0.085	0.070	4.224	0.081	0.187	0.038
				0.534	0.115	0.223	94.2	0.283	0.170	0.066	4.399	0.084	0.137	0.034
				0.720	0.102	0.231	93.8	0.291	0.133	0.072	4.609	0.100	0.143	0.027
				0.251	0.068	0.256	94.5	0.271	0.082	0.069	4.493	0.102	0.180	0.061
				0.171	0.089	0.197	95.0	0.276	0.120	0.065	4.009	0.078	0.185	0.012
Naviglione 01	sword	complete	MBA	0.193	0.122	0.545	84.3	0.220	0.708	0.001	7.633	0.099	6.715	0.024
				0.201	0.123	0.679	86.2	0.223	0.614	0.006	5.853	0.077	6.681	0.035
				0.246	0.081	0.527	82.1	0.195	0.919	0.002	7.751	0.091	8.649	0.099

				0.140	0.132	0.650	87.9	0.253	0.572	0.006	6.251	0.081	4.677	0.005
				0.743	0.035	0.034	75.2	0.199	0.362	0.005	22.350	0.569	0.540	0.007
				0.117	0.097	0.505	87.8	0.186	0.277	0.012	10.040	0.217	1.215	0.008
Sposetta 04	dagger	complete	MBA	0.099	0.068	0.051	94.6	0.286	0.062	0.029	4.742	0.028	0.079	0.000
				0.032	0.073	0.029	94.7	0.292	0.045	0.034	4.670	0.024	0.108	0.000
				0.111	0.056	0.013	94.6	0.270	0.036	0.037	4.789	0.024	0.093	0.017
				0.188	0.093	0.057	87.9	0.258	0.000	0.033	10.700	0.042	0.713	0.034
Unknown site 01	axe	complete	MBA	0.464	0.045	0.228	88.1	0.318	0.035	0.010	10.990	0.007	0.006	0.014
				0.552	0.068	0.201	88.5	0.326	0.027	0.009	10.610	0.004	0.006	0.012
				0.450	0.048	0.193	89.2	0.329	0.019	0.008	9.980	0.006	0.005	0.006
Capo Linaro 01	sword	complete	LBA	0.152	0.087	0.698	77.2	0.322	0.335	0.184	21.260	0.105	0.336	0.095
				0.257	0.090	0.611	78.2	0.310	0.258	0.259	19.990	0.104	0.500	0.113
Mezzano 08	axe	complete	LBA	0.085	0.099	0.094	89.9	0.291	0.183	0.104	8.839	0.041	0.451	0.069
				1.546	0.086	0.047	88.2	0.253	0.212	0.112	8.991	0.064	0.481	0.092
				0.873	0.084	0.099	87.5	0.277	0.197	0.129	10.380	0.070	0.500	0.083
				1.212	0.052	0.044	88.5	0.266	0.199	0.109	9.163	0.067	0.486	0.073
Mezzano 09	axe	complete	LBA	6.180	0.127	0.151	84.7	0.273	0.628	0.078	7.539	0.121	0.476	0.055
				2.492	0.119	0.125	89.0	0.274	0.327	0.067	7.255	0.116	0.357	0.070
				8.027	0.116	0.122	82.8	0.291	0.703	0.076	7.659	0.108	0.490	0.112
				0.464	0.124	0.192	91.3	0.319	0.180	0.068	7.069	0.111	0.355	0.034
				0.421	0.132	0.195	91.3	0.308	0.251	0.082	6.971	0.112	0.396	0.071
Mezzano 10	sword	complete	LBA	0.003	0.114	0.205	89.6	0.266	0.090	0.076	9.426	0.075	0.320	0.037
				0.173	0.092	0.191	88.6	0.247	0.129	0.080	10.200	0.081	0.358	0.022
				0.115	0.121	0.181	89.4	0.276	0.128	0.072	9.616	0.067	0.194	0.020
				0.041	0.089	0.160	89.8	0.258	0.099	0.068	9.300	0.083	0.249	0.007
				0.148	0.073	0.165	89.3	0.259	0.099	0.095	9.611	0.079	0.289	0.013
				0.098	0.116	0.170	89.5	0.283	0.078	0.080	9.409	0.076	0.300	0.030
				0.225	0.123	0.156	89.4	0.283	0.118	0.079	9.415	0.073	0.298	0.029
				0.128	0.089	0.163	89.4	0.262	0.154	0.076	9.445	0.082	0.321	0.042
				0.730	0.117	0.245	87.9	0.263	0.310	0.084	10.160	0.076	0.317	0.046
				0.282	0.071	0.176	88.6	0.237	0.138	0.080	10.150	0.074	0.315	0.027
Mezzano 11	sword	complete	LBA	0.045	0.096	0.057	91.6	0.247	0.126	0.082	7.462	0.094	0.209	0.052
				0.000	0.089	0.109	91.6	0.251	0.188	0.082	7.511	0.083	0.207	0.031
				0.345	0.056	0.049	91.2	0.221	0.147	0.081	7.718	0.078	0.139	0.042
				0.000	0.089	0.109	91.6	0.251	0.188	0.082	7.511	0.083	0.207	0.031
				0.141	0.089	0.112	91.5	0.247	0.163	0.077	7.493	0.087	0.194	0.034
				0.745	0.085	0.047	88.7	0.334	0.146	0.119	9.380	0.082	0.445	0.016
				1.209	0.096	0.000	87.1	0.245	0.161	0.136	10.620	0.080	0.408	0.029
Mezzano 12	spear	complete	LBA	1.567	0.060	0.129	86.2	0.224	0.202	0.051	11.150	0.061	0.535	0.026
				10.640	0.033	0.076	74.2	0.218	0.810	0.046	13.810	0.061	0.686	0.052
				1.560	0.112	0.130	82.7	0.293	0.312	0.066	14.390	0.070	0.487	0.019
				89.110	0.116	0.000	1.4	1.121	3.368	0.017	4.718	0.023	0.010	0.010
				18.630	0.137	0.000	57.4	0.555	1.633	0.207	20.680	0.030	0.575	0.108
				0.843	0.080	0.163	87.7	0.291	0.127	0.044	10.380	0.064	0.437	0.017
Mezzano 13	spear	complete	LBA	1.291	0.108	0.078	87.8	0.284	0.203	0.093	9.657	0.120	0.440	0.055
				2.283	0.106	0.104	86.8	0.286	0.190	0.088	9.664	0.134	0.493	0.045
				2.410	0.113	0.067	86.5	0.272	0.166	0.085	9.915	0.135	0.506	0.045
				1.247	0.095	0.092	87.1	0.269	0.247	0.099	10.330	0.139	0.469	0.068
Mezzano 14	fibula	complete	LBA	0.706	0.199	0.150	90.2	0.290	0.409	0.096	8.058	0.017	0.149	0.047
				0.879	0.215	0.110	89.6	0.276	0.391	0.075	8.438	0.014	0.135	0.016
				1.280	0.227	0.100	88.6	0.313	0.472	0.057	8.956	0.016	0.170	0.056

(*Continued*)

Table A1. Continued.

Object ID	Type	Conditions	Chronology	Fe (wt%)	Co (wt%)	Ni (wt%)	Cu (wt%)	Zn (wt%)	As (wt%)	Ag (wt%)	Sn (wt%)	Sb (wt%)	Pb (wt%)	Bi (wt%)
				1.266	0.267	0.167	88.5	0.354	0.433	0.048	9.144	0.027	0.235	0.058
Mezzano 15	shovel	complete	LBA	0.340	0.145	0.195	93.1	0.342	0.109	0.095	5.168	0.157	0.567	0.049
				0.366	0.115	0.121	93.0	0.292	0.178	0.101	5.038	0.161	0.731	0.066
Sposetta 01	pin	fragmented	LBA	0.562	0.082	0.081	91.0	0.353	0.115	0.103	7.172	0.162	0.456	0.052
				0.524	0.083	0.056	90.4	0.370	0.166	0.096	7.852	0.152	0.348	0.037
				154	0.045	0.093	89.2	0.363	0.156	0.104	8.320	0.167	0.449	0.044
				0.654	0.077	0.000	90.4	0.373	0.139	0.105	7.727	0.158	0.348	0.032
Sposetta 03	razor	complete	LBA	0.070	0.122	0.110	87.6	0.265	0.145	0.077	11.360	0.065	0.287	0.044
				0.173	0.067	0.075	87.2	0.237	0.150	0.080	11.700	0.068	0.283	0.043
				0.178	0.109	0.057	87.4	0.271	0.138	0.071	11.460	0.053	0.253	0.035
				0.407	0.077	0.000	87.8	0.289	0.163	0.116	10.820	0.055	0.245	0.064
				2.052	0.102	0.048	85.8	0.267	0.143	0.127	11.240	0.059	0.263	0.074
Sposetta 05	pin	complete	LBA	1.130	0.078	0.007	90.2	0.321	0.093	0.070	7.753	0.038	0.280	0.049
				4.182	0.093	0.050	85.4	0.316	0.102	0.083	9.489	0.041	0.421	0.088
Isola Bisentina 01	sickle	complete	FBA	0.215	0.329	0.578	92.7	0.270	0.522	0.175	2.227	0.834	2.750	0.070
				0.341	0.310	0.526	92.4	0.260	0.598	0.192	2.416	0.867	2.616	0.078
				0.103	0.363	0.682	92.8	0.384	0.441	0.199	2.325	0.872	2.828	0.069
				0.259	0.339	0.533	92.0	0.251	0.630	0.189	2.401	0.879	3.044	0.081
Pianizza 01	axe	complete	FBA	0.126	0.167	0.203	86.7	0.292	0.341	0.165	9.885	0.418	1.770	0.082
				0.096	0.174	0.268	88.0	0.325	0.281	0.163	8.862	0.366	1.743	0.083
				0.185	0.136	0.273	88.4	0.273	0.319	0.149	8.531	0.357	1.658	0.026
				0.122	0.154	0.261	87.7	0.379	0.333	0.155	9.210	0.370	1.836	0.034
				0.093	0.196	0.211	88.1	0.296	0.216	0.142	8.782	0.383	1.736	0.057
Poggi del Mulino-Casale Moscini 01	pin	complete	FBA	0.065	0.056	0.373	87.5	0.331	0.242	0.096	10.930	0.098	0.676	0.058
Poggi del Mulino-Casale Moscini 02	ingot	fragmented	FBA	0.847	0.035	0.000	98.1	0.336	0.361	0.159	0.008	0.051	0.096	0.008
Poggi del Mulino-Casale Moscini 03	ingot	fragmented	FBA	0.025	0.043	0.000	99.1	0.385	0.232	0.105	0.005	0.008	0.083	0.179
Poggi del Mulino-Casale Moscini 04	ingot	fragmented	FBA	0.833	0.299	0.055	96.6	0.319	1.870	0.086	0.061	0.008	0.212	0.005
				2.229	0.162	0.000	92.8	0.318	3.305	0.149	0.105	0.025	1.042	0.019
				1.876	0.237	0.000	93.2	0.310	4.048	0.121	0.121	0.009	0.340	0.017
Selvicciola hoard 01	axe	complete	EIA	0.073	0.114	0.390	90.8	0.260	0.345	0.156	6.322	0.920	0.930	0.064
				0.008	0.156	0.431	89.9	0.265	0.467	0.159	6.876	1.002	0.974	0.073
				0.006	0.133	0.386	91.5	0.293	0.366	0.137	5.744	0.845	0.893	0.070
Selvicciola hoard 02	axe	complete	EIA	0.009	0.180	0.321	91.8	0.337	0.441	0.082	6.243	0.427	0.363	0.053
				0.063	0.200	0.373	88.2	0.308	0.721	0.115	8.523	0.561	1.001	0.031
				0.048	0.169	0.401	89.6	0.270	0.615	0.105	7.959	0.538	0.569	0.070
Selvicciola hoard 03	axe	complete	EIA	0.185	0.120	0.308	92.4	0.280	0.253	0.103	5.446	0.465	0.675	0.019
				0.200	0.121	0.321	92.9	0.274	0.274	0.098	5.118	0.417	0.587	0.035
				0.166	0.103	0.303	92.3	0.270	0.292	0.111	5.570	0.441	0.688	0.020
Selvicciola hoard 04	axe	fragmented	EIA	0.601	1.035	2.956	70.6	0.209	1.350	0.968	0.046	6.218	10.910	0.074
				0.473	0.988	3.026	73.0	0.224	1.480	1.007	0.047	6.601	10.010	0.072
				0.555	1.050	3.300	74.4	0.213	1.407	0.925	0.036	6.096	10.130	0.115
Selvicciola hoard 04	axe	fragmented	EIA	0.648	1.023	1.907	65.6	0.196	1.705	1.016	0.073	7.750	22.310	0.119
				1.220	1.209	2.002	51.8	0.140	1.781	1.028	0.067	8.006	35.710	0.170
				0.852	1.306	2.118	60.0	0.194	1.629	0.999	0.067	7.400	28.070	0.133
Selvicciola hoard 04	axe	fragmented	EIA	0.436	0.778	2.662	64.3	0.179	1.936	1.225	0.049	6.848	24.450	0.147
				0.715	1.187	2.689	70.9	0.209	2.236	0.857	0.057	6.836	17.290	0.095
				0.699	1.329	3.489	69.8	0.208	2.091	0.855	0.052	7.718	17.610	0.085
Selvicciola hoard 04	axe	fragmented	EIA	0.545	1.145	2.502	66.7	0.167	1.337	0.709	0.063	5.055	24.320	0.143
				0.571	1.098	2.535	65.7	0.162	1.382	0.760	0.061	5.271	25.060	0.118

				0.610	1.073	2.616	70.1	0.174	0.879	0.672	0.054	4.675	21.700	0.132
Selvicciola hoard 05	axe	fragmented	EIA	0.596	0.686	1.854	84.1	0.298	2.188	1.468	0.066	10.520	0.138	0.039
				2.478	0.751	2.888	70.3	0.289	4.583	2.693	0.084	18.960	0.423	0.045
				0.207	0.879	2.707	84.2	0.267	2.291	1.328	0.061	10.720	0.102	0.022
Selvicciola hoard 05	axe	fragmented	EIA	69.480	1.074	0.000	25.7	0.054	0.168	0.002	0.018	0.004	2.535	0.017
Selvicciola hoard 05	axe	fragmented	EIA	0.300	1.547	2.780	77.8	0.236	1.641	0.820	0.326	6.352	11.170	0.085
				0.102	1.635	3.125	76.3	0.204	1.819	0.842	0.355	6.583	12.320	0.088
				0.130	1.554	3.174	77.2	0.213	1.772	0.860	0.368	6.674	11.420	0.084
Selvicciola hoard 05	axe	fragmented	EIA	0.343	0.276	1.740	87.0	0.299	2.389	1.155	0.133	8.291	0.126	0.001
				0.372	0.261	1.674	86.7	0.284	2.411	1.244	0.135	8.492	0.115	0.019
				0.185	0.253	1.758	89.1	0.287	1.937	1.078	0.126	6.930	0.123	0.016
Selvicciola hoard 05	axe	fragmented	EIA	0.353	1.092	2.768	61.8	0.130	2.149	0.906	0.045	7.430	26.440	0.119
				0.370	1.008	2.719	65.3	0.149	2.484	0.827	0.051	7.375	22.760	0.112
				0.650	0.996	2.798	57.6	0.122	2.370	0.942	0.055	8.007	29.870	0.149
Selvicciola hoard 05	axe	fragmented	EIA	0.369	0.177	0.098	78.7	0.231	0.151	0.185	0.030	0.381	19.290	0.096
				0.223	0.141	0.087	78.2	0.251	0.321	0.188	0.023	0.384	19.710	0.100
				1.040	0.150	0.074	75.9	0.184	0.302	0.248	0.030	0.381	21.390	0.055
Selvicciola hoard 06	axe	fragmented	EIA	0.011	0.207	1.226	78.3	0.207	0.553	0.448	0.983	2.645	16.340	0.088
				0.003	0.227	1.072	75.1	0.175	0.521	0.440	0.956	2.511	19.590	0.145
				0.049	0.204	1.211	78.6	0.187	0.448	0.443	0.991	2.658	16.120	0.104
Selvicciola hoard 07	gouge-awl	complete	EIA	0.211	0.193	0.430	91.4	0.272	0.506	0.173	5.876	0.865	0.473	0.096
				0.246	0.210	0.444	90.5	0.297	0.568	0.184	6.485	0.895	0.599	0.061
				0.179	0.199	0.415	91.6	0.281	0.507	0.160	5.774	0.835	0.403	0.094
Selvicciola hoard 08	ring	fragmented	EIA	2.522	0.592	1.689	60.3	0.152	1.632	0.769	0.548	5.614	28.600	0.094
				1.735	0.573	1.784	64.2	0.155	1.121	0.620	0.385	5.104	26.390	0.149
				2.093	0.562	1.682	66.6	0.171	1.228	0.574	0.409	4.957	23.790	0.157
Selvicciola hoard 09	bracelet	fragmented	EIA	0.368	0.590	1.848	68.5	0.172	1.607	0.620	0.154	5.121	22.730	0.074
				0.436	0.542	1.880	67.9	0.159	2.020	0.682	0.184	5.561	22.470	0.150
				0.547	0.599	2.049	58.4	0.150	1.766	0.671	0.172	5.489	32.190	0.129
Selvicciola hoard 10	ingot	fragmented	EIA	0.343	0.369	1.765	61.7	0.127	0.580	0.428	0.089	3.815	31.940	0.155
				0.273	0.353	1.766	60.3	0.143	0.495	0.434	0.076	3.675	33.530	0.133
				0.772	0.371	1.159	54.9	0.131	0.886	0.495	0.108	4.355	37.660	0.166
				0.409	0.323	1.690	62.7	0.156	0.703	0.425	0.088	4.045	30.560	0.159
Selvicciola hoard 11	ingot	fragmented	EIA	0.103	0.478	1.856	72.2	0.174	0.898	0.353	0.041	3.376	21.930	0.095
				0.066	0.476	1.815	72.8	0.189	0.421	0.322	0.031	2.082	22.990	0.070
				0.066	0.447	1.499	70.2	0.179	0.896	0.412	0.027	2.308	24.850	0.109

Note: Whenever possible multiple measurements were performed on different points of the object; each line accounts for one measurement. For object identification, see the Catalogue of the analyzed findings. Abbreviations: EN = Eneolithic; EBA = Early Bronze Age; MBA = Middle Bronze Age; LBA = Late Bronze Age; FBA = Final Bronze Age; EIA = Early Iron Age.

Table A2. Results of the analyses, mean values calculated over all the measurements performed on the item.

Object id	Type	Conditions	Chronology	Fe (wt%)	Co (wt%)	Ni (wt%)	Cu (wt%)	Zn (wt%)	As (wt%)	Ag (wt%)	Sn (wt%)	Sb (wt%)	Pb (wt%)	Bi (wt%)
Grotta Fichina 01	axe	complete	EN	0.174	0.092	0.100	97.780	0.292	0.633	0.197	0.011	0.720	0.063	0.034
Monte S. Angelo 01	axe	complete	EN	0.124	0.024	0.000	97.970	0.363	1.377	0.126	0.001	0.007	0.015	0.099
Ortaccia 1	axe	complete	EN	0.044	0.086	0.136	99.090	0.313	0.205	0.027	0.009	0.151	0.056	0.029
Ortaccia 2	dagger	complete	EN	0.069	0.101	0.154	93.615	0.302	3.621	0.297	0.012	1.867	0.110	0.031
Palombaro 1	axe	complete	EN	0.046	0.084	0.126	99.120	0.316	0.055	0.047	0.005	0.228	0.081	0.037
Pianetti 1	axe	complete	EN	0.133	0.022	0.000	99.340	0.364	0.037	0.040	0.001	0.057	0.007	0.006
Poggio degli Spiriti 1	dagger	complete	EN	0.026	0.086	2.504	94.545	0.290	1.000	1.555	0.011	2.542	0.010	0.007
Poggio Spolverino 1	dagger	complete	EN	0.473	0.020	0.000	94.450	0.343	4.588	0.106	0.005	0.005	0.013	0.023
Selvicciola necropolis 1	dagger	complete	EN	0.048	0.088	0.097	96.565	0.302	2.837	0.088	0.005	0.010	0.031	0.159
Selvicciola necropolis 2	dagger	complete	EN	0.113	0.073	0.155	95.663	0.304	3.522	0.103	0.004	0.020	0.195	0.022
Selvicciola necropolis 3	dagger	complete	EN	0.060	0.096	0.255	92.077	0.285	5.338	0.140	0.020	1.852	0.097	0.014
Selvicciola necropolis 4	awl	complete	EN	0.028	0.034	0.000	99.540	0.330	0.010	0.034	0.002	0.020	0.016	0.011
Selvicciola necropolis 5	awl	complete	EN	0.034	0.029	0.000	99.280	0.317	0.030	0.041	0.003	0.174	0.102	0.011
Selvicciola necropolis 6	awl	complete	EN	0.191	0.022	0.000	94.350	0.317	3.578	0.083	0.013	1.141	0.312	0.005
Territorio di Marta 1	axe	complete	EN	0.008	0.061	0.056	99.422	0.268	0.015	0.066	0.006	0.096	0.041	0.028
Territorio di Marta 2	axe	complete	EN	0.062	0.058	0.048	98.913	0.274	0.034	0.208	0.007	0.377	0.046	0.028
Mezzano 1	pin	complete	EBA	0.451	0.131	0.106	89.000	0.601	0.309	0.022	8.134	0.167	1.168	0.058
Mezzano 2	pin	complete	EBA	4.922	0.061	0.248	90.614	0.286	0.175	0.031	3.757	0.064	0.170	0.041
Mezzano 3	axe	complete	EBA	0.562	0.128	0.067	87.496	0.848	0.267	0.032	9.736	0.097	0.720	0.063
Mezzano 4	axe	complete	EBA	1.847	0.109	0.102	84.974	0.692	0.443	0.039	10.594	0.139	1.214	0.073
Mezzano 5	axe	complete	EBA	1.281	0.090	0.106	90.226	0.557	0.301	0.016	6.146	0.055	1.307	0.038
Monte S. Angelo 2	axe	complete	EBA	1.101	0.031	0.235	85.110	0.605	0.456	0.010	12.173	0.013	0.525	0.016
Rota 1	axe	complete	EBA	0.244	0.031	0.291	79.663	0.627	0.926	0.072	13.427	0.164	4.871	0.136
Sposetta 2	pin	complete	EBA	0.593	0.093	0.207	93.667	0.259	0.181	0.075	4.802	0.112	0.201	0.042
Località ignota 1	axe	complete	MBA	0.489	0.054	0.207	88.590	0.324	0.027	0.009	10.527	0.005	0.005	0.011
Mezzano 6	axe	complete	MBA	7.999	0.130	0.089	82.405	0.404	0.314	0.019	8.799	0.018	0.068	0.012
Mezzano 7	dagger	complete	MBA	0.387	0.091	0.227	94.426	0.284	0.118	0.068	4.347	0.089	0.167	0.034
Naviglione 1	sword	complete	MBA	0.195	0.114	0.600	85.113	0.223	0.703	0.004	6.872	0.087	6.681	0.041
Naviglione 1	nail	complete	MBA	0.430	0.066	0.270	81.510	0.192	0.319	0.009	16.195	0.393	0.877	0.007
Sposetta 4	dagger	complete	MBA	0.108	0.073	0.037	92.948	0.277	0.036	0.034	6.225	0.030	0.248	0.013
Capollnaro 1	sword	complete	LBA	0.168	0.094	0.620	78.630	0.318	0.284	0.225	19.737	0.106	0.448	0.105
Mezzano 10	sword	complete	LBA	0.194	0.101	0.181	89.156	0.263	0.134	0.079	9.673	0.077	0.296	0.027
Mezzano 11	sword	complete	LBA	0.355	0.086	0.069	90.446	0.256	0.160	0.094	8.242	0.084	0.258	0.034
Mezzano 12	spear	complete	LBA	20.392	0.090	0.083	64.913	0.450	1.076	0.072	12.521	0.051	0.455	0.039
Mezzano 13	spear	complete	LBA	1.808	0.105	0.085	87.050	0.278	0.202	0.091	9.892	0.132	0.477	0.053
Mezzano 14	fibula	complete	LBA	1.033	0.227	0.132	89.188	0.308	0.427	0.069	8.649	0.018	0.172	0.044
Mezzano 15	paletta	complete	LBA	0.353	0.130	0.158	93.040	0.317	0.143	0.098	5.103	0.159	0.649	0.058
Mezzano 8	axe	complete	LBA	0.929	0.080	0.071	88.520	0.272	0.198	0.114	9.343	0.060	0.479	0.079
Mezzano 9	axe	complete	LBA	3.517	0.123	0.157	87.840	0.293	0.418	0.074	7.299	0.114	0.415	0.068
Sposetta 1	pin	complete	LBA	0.724	0.071	0.058	90.255	0.364	0.144	0.102	7.768	0.160	0.400	0.041
Sposetta 3	razor	complete	LBA	0.140	0.099	0.081	87.410	0.258	0.144	0.076	11.507	0.062	0.274	0.041
Sposetta 3	nail	complete	LBA	1.230	0.089	0.024	86.805	0.278	0.153	0.121	11.030	0.057	0.254	0.069
Sposetta 5	awl	complete	LBA	2.656	0.085	0.029	87.815	0.318	0.098	0.077	8.621	0.040	0.351	0.068
Isola Bisentina 1	sickle	complete	FBA	0.229	0.335	0.580	92.458	0.291	0.548	0.189	2.342	0.863	2.810	0.074
Pianizza 1	axe	complete	FBA	0.124	0.165	0.243	87.782	0.313	0.298	0.155	9.054	0.379	1.749	0.056
Poggi del Mulino-Casale Moscini 1	pin	complete	FBA	0.065	0.056	0.373	87.490	0.331	0.242	0.096	10.930	0.098	0.676	0.058
Poggi del Mulino-Casale Moscini 2	ingot	fragmented	FBA	0.847	0.035	0.000	98.120	0.336	0.361	0.159	0.008	0.051	0.096	0.008
Poggi del Mulino-Casale Moscini 3	ingot	fragmented	FBA	0.025	0.043	0.000	99.140	0.385	0.232	0.105	0.005	0.008	0.083	0.179
Poggi del Mulino-Casale Moscini 4	ingot	fragmented	FBA	1.646	0.233	0.018	94.187	0.315	3.074	0.119	0.096	0.014	0.531	0.014

Selvicciola hoard 1	axe	complete	EIA	0.029	0.134	0.403	90.727	0.273	0.393	0.151	6.314	0.922	0.932	0.069
Selvicciola hoard 10	ingot	fragmented	EIA	0.449	0.354	1.595	59.878	0.139	0.666	0.445	0.090	3.973	33.423	0.153
Selvicciola hoard 11	ingot	fragmented	EIA	0.078	0.467	1.723	71.753	0.181	0.738	0.362	0.033	2.589	23.257	0.092
Selvicciola hoard 2	axe	complete	EIA	0.040	0.183	0.365	89.877	0.305	0.592	0.101	7.575	0.509	0.644	0.051
Selvicciola hoard 3	axe	complete	EIA	0.184	0.115	0.311	92.520	0.275	0.273	0.104	5.378	0.441	0.650	0.025
Selvicciola hoard 4	axe	fragmented	EIA	0.543	1.024	3.094	72.663	0.215	1.412	0.967	0.043	6.305	10.350	0.087
Selvicciola hoard 4	axe	fragmented	EIA	0.9067	1.1793	2.0090	59.1533	0.1765	1.7050	1.0142	0.0691	5.1612	28.6933	0.1406
Selvicciola hoard 4	axe	fragmented	EIA	0.617	1.098	2.947	68.337	0.198	2.088	0.979	0.053	7.134	19.783	0.109
Selvicciola hoard 4	axe	fragmented	EIA	0.575	1.105	2.551	67.517	0.168	1.199	0.714	0.059	5.000	23.693	0.131
Selvicciola hoard 5	axe	fragmented	EIA	1.094	0.772	2.483	79.533	0.285	3.021	1.830	0.071	13.400	0.221	0.035
Selvicciola hoard 5	axe	fragmented	EIA	69.480	1.074	0.000	25.710	0.054	0.168	0.002	0.018	0.004	2.535	0.017
Selvicciola hoard 5	axe	fragmented	EIA	0.177	1.579	3.026	77.087	0.218	1.744	0.841	0.350	6.536	11.637	0.086
Selvicciola hoard 5	axe	fragmented	EIA	0.300	0.263	1.724	87.590	0.290	2.246	1.159	0.132	7.904	0.121	0.012
Selvicciola hoard 5	axe	fragmented	EIA	0.457	1.032	2.762	61.563	0.134	2.334	0.892	0.050	7.604	26.357	0.127
Selvicciola hoard 5	axe	fragmented	EIA	0.544	0.156	0.086	77.587	0.222	0.258	0.207	0.028	0.382	20.130	0.084
Selvicciola hoard 6	axe	fragmented	EIA	0.021	0.212	1.170	77.297	0.190	0.507	0.444	0.977	2.605	17.350	0.112
Selvicciola hoard 7	gouge-awl	complete	EIA	0.212	0.201	0.430	91.183	0.283	0.527	0.172	6.045	0.865	0.492	0.083
Selvicciola hoard 8	ingot	fragmented	EIA	2.117	0.576	1.718	63.673	0.159	1.327	0.654	0.447	5.225	26.260	0.133
Selvicciola hoard 9	ingot	fragmented	EIA	0.450	0.577	1.926	64.940	0.161	1.798	0.658	0.170	5.390	25.797	0.118

Note: For object identification, see the Catalogue of the analyzed findings. Abbreviations: EN = Eneolithic; EBA = Early Bronze Age; MBA = Middle Bronze Age; LBA = Late Bronze Age; FBA = Final Bronze Age; EIA = Early Iron Age.