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SOME ASPECTS OF PREHISTORIC AND PROTOHISTORIC METALLURGY IN LIGURIA (NORTH-WEST ITALY)

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ABSTRACT. The developement of metallurgy in Liguria during the Chalcolithic and Bronze Age has not been studied completely until now. There is also a lack of general synthesis of archaeometallurgical analysis and a solid study approach towards the exploitation of local copper resources. According to recent studies, during the "metals age" Liguria had an important role in the circulation and re-elaboration of metals artefacts between Northern Italy and Tirreno Sea and Provence. A progressive circulation of metal objects since the Chalcolithic resulted in the development of local and independent metallurgy in Liguria, mostly in the Final Bronze Age; at this time the West area of Liguria probably belonged to the "metallurgical circle of Westerns Alps" and this increased the exploitation of local copper resources. Various archaeometallurgical analyses, carried out in the last 30 years, had indicated a development of metalworks and copper resources exploitation.

Introduction

Liguria in North West Italy is an important region for passage between the Ligurian Sea and the Padan Plain throught the Apennine Mountain (Fig. 1). During the pre-Roman Age the area was occupied by the tribal society of Liguri, settled between the North Etrurian coast and the Provence and was described by various Greek authors (Herodotus, Polibius, Strabon) since VI c. BC (Colonna, 2004).

Fig. 1. Liguria region in North West Italy

Liguria was always considered to have been occupied by barbaric people until the Roman period, that were still in a state of technological evolution since the Neolithic and that were not capable of any metalwork. Until recent archaeological studies, there was no much evidence about copper and bronze objects. The research of pre- and protohistoric metal artefacts in Liguria has developed quite recently. After his discovery in 1951 of the Iron Age necropolis of Chiavari with a rich bronze and iron gravesets, N. Lamboglia (1965) was obliged to review his theory about the incapacity of ancient Ligurian society of metallurgical activity and the necessity to import or pillage metal objects (1939). In fact, the lack of discovery of metal objects since XIX c. and the absence of directs smelting and melting products as ingots (*aes rudes*), slags and discards of metallurgical activity, validated this concept. The only data in discordance was the discovery of hammerstones in the copper mines of Libiola and M. Loreto in 1879 that were considered as generally old (Issel, 1879) and later compared with similar objects from the Halstatt Iron Age mines (Isetti, 1964): in that case the supposed Iron Age exploitation of these copper mines and the many bronze objects in the near Iron Age necropolis of Chiavari imposed a different view on the ancient Liguri as copper and bornze producers. The most recent studies by Maggi and Pearce (2003; 2005) confirmed the antiquity of copper exploitation in M. Loreto copper mine, since the IV mill. BC. In 1989 the excavation of the Middle Bronze Age settlement of Bric Tana in West Liguria, allowed the discovery of two metal drops attached together, one of copper and the other one of bronze (Del Lucchese et al., 1989): this discovery shows the capacity of the Bronze Age Liguri for production not only of copper but also of bronze.

In this way, recently, other very large discoveries of bronze objects, metal ingots, metal depots, mainly in Western Liguria, confirmed the new evaluation of metal production during the Bronze Age in that region, mostly for the Final Bronze Age (Del Lucchese, Delfino, 2008).

In another part of the research, the archaeo-metallurgical analyses, the study directions for Liguria's copper and bronze objects are mainly devoted to finding the exploitation areas of copper (local or not local) and to the study of ancient metallurgical techniques. For the former the research was developed during the lasts twenty years of the XX c. (Maggi,

Formicola, 1978; Del Lucchese et al., 1994; Franceschi et al., 1997; Franceschi, 2000) and has been conducted with inappropriate (XRF, XRD, SEM-EDS) or old-fashioned methods; or by studying finished bronze objects, that does not correspond to the criteria for research of the origin of materials (high probability of refund phenomenon). Only a few recent studies that will be presented in this work, have reached acceptable data, based on sure objects as raw ingots. For the latter study (ancient metallurgical techniques), the research conducted with radiography and metallographic microscope observed a very little number of metal artefacts (Ienco et al., 1995; Franceschi, Campana, 1988).

Metallurgy production in Liguria during the Copper and Bronze Age (IV mill. BC – IX c. BC), between import, circulation and local production

During the "metal Ages" the amount and distribution of metals objects in archaeological contexts is variable and in many cases datable only by typological study. During the Copper Age a total of 19 objects (9 tools, 2 armlets, 8 ornaments) are all distributed in burial contexts, 6 in caves and 1 in tumulus. During the Early Bronze Age a total of 21 objects (11 tools, 1 armlet, 9 ornaments) are distributed in 1 depot (3 axes), 5 burials (all in caves), 1 settlement in rock shelter, 3 stray finds. In the Middle Bronze Age a total of 16 objects (4 tools, 2 armlet, 8 ornaments, 2 metalwork objects) are distributed in 4 settlements (3 in open air and 1 in a cave) and 2 stray finds. In the Late Bronze Age a total of 26 objects (1 tool, 7 armlets, 12 ornaments, 6 metalwork objects) are distributed in 4 hilltop settlement, 1 burial, 1 stray find. During the Final Bronze Age a total of 120 objects (19 tools, 12 armlets, 32 ornaments, 57 metalwork objects) are distributed in 4 hilltop settlements, 1 burial, 5 bronze depots, 5 stray finds.

Metal work and circulation of metal object in the Copper Age (3600-2000 BC): external metallurgical connections in western Liguria

During this period, copper objects were found in burials, that in Liguria Copper Age are only in caves, with an exception of the Bell Beaker tumulus in Castellari di Loano (Western coast of Liguria) (Odetti, 1998). Situated on a hill top with a strategic view over the near sea coast and plain, multiple inhumations were found in this tumulus with Bell Beaker graveset and copper objects: five awls (one "as lozenge form") (Fig. 2), one belt hook, two pearls and one plate in arsenical copper.

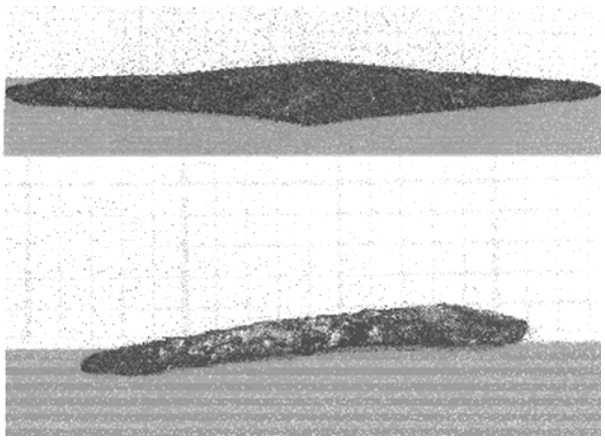

Fig. 2. Awl rich in nickel and awl as lozenge form rich in silver from bell beaker tumulus in Castellari di Loano (Savona)

The chemical composition map obtained with SEM-EDS spectrograph (Franceschi et al., 1998) has found non trace elements (>1%), a relatively high quantity of nickel (from 4.5% to 1.5%) and antimony (1.6%) in the tree awls, of silver (5.2%) in the awl "as lozenge form" and in the plate arsenic (2.1%), silver (3%) and lead (1.7%): that high percentages of minor elements (nickel, antimony, arsenic and silver) is an anomalous respect of others copper objects of the Copper Age in Liguria analysed (Del Lucchese et al., 1994), and shows an example of the diversity of the used type of copper. In the Pollera cave (Western Liguria, near the sea coast), containing several settlements and burials from the Neolithic to the Middle Bronze Age (Odetti, 1972), the Bell Beaker inhumation contains as a graveset a copper dagger, various awls and an arrow point. This is a Palmela type, part of characteristic graveset elements of the Bell Beaker burials in Western Mediterranean: a re-cooking treatment traceable in this sample and visible with metallographic observation, is characteristic of the Palmela arrow point subtypes A and B in the Iberian Peninsula (Del Lucchese et al., 1994). Unfortunately, it is not possible to view the chemical composition of the arrow point, since only a XRF analysis in superficial patina had been carried out that is not reliable for mapping of chemical composition of metallic matrix. The dagger found with the arrow point has a trapezoidal base with four holes for handle, a type not frequent in the Italian repository, but characteristic for the South of France. A metallographic observation would probably find sulphide traces in a metallic matrix, not normal in Copper Age metallurgy, but this needs confirmation by a SEM-EDS analysis. The test of microhardness has identified mechanical work, but not thermal treatment (Del Lucchese et al., 1994). The uniqueness of the archaeometallurgical context in these two sites of Western Ligurian Sea coast, is an indicator for a possible external ethnic group presence, with own metallurgical technique, located in a strategic point in this part of the region. Other typological connections, with the Italian Peninsula, have been highlighted for a grave in Grotta della Ciappa Superiore cave (Eastern Liguria, near the Monte Loreto copper mine): various objects form the graveset, particularly an arsenical copper blade are similar to samples found in Tuscany, Grotta dei Sassi Neri and Puglia, Laterza cave (Maggi, 1998); probably they had been casted from a local copper of the Monte Loreto mine (Maggi et al., 1986).

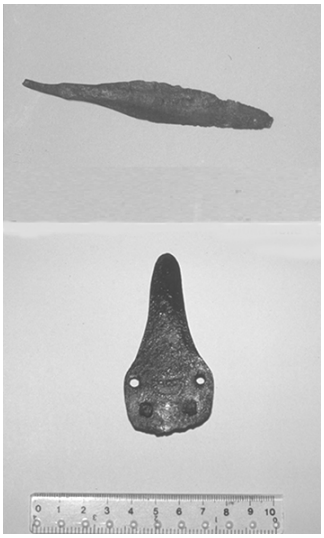

Fig. 3. Arrow point "Palmela type" and dagger from Pollera cave

Early Bronze Age (2000-1600 BC): bronze objects circulation and storage

The circulation of the first bronze objects was highlighted by six axes found near the mountain passes of the Apennines close to the Sea coast. An interesting site is the first metal depot in Liguria in the Rocca delle Fene site (Western coast of Liguria), a hill top near the Sea coast and the Castellari di Loano Bell Beaker tumulus. An original depot, found at the end of the XIX c. was composed by 3 axes, all eguals, belonging to the "Farneto-Scandiano" axes type (Fig. 4) (Del Lucchese et al., 1994) and therefore datable in the Early Bronze Age (Bz-A2); the only surviving axe is in a very poor state but still has usage marks. The site of discovery is a little pit in a hardly accessible top hill: probably the depot was a reserve of bronze for recycling composed by axes with bronze of 92% copper and 8% tin (Del Lucchese et al., 1994).

Other axes, found in the Apennine Mountains near the passage of Pinanura Padana, belonged to "Farneto Scandiano" type (found in Pian del Casale, Eastern Liguria) (Del Lucchese et al., 1994), to "Paestum" and to "Neyruz" type (found in Sassello, Western Liguria) (Del Lucchese, 1998a): all the axes are stray finds ascribed to the Advanced Early Bronze Age, except for the "Neyruz" type (Fisrt Bronze Age/Bz A1). Circulation of axes from the Italian Peninsula and the Western Alps is shown by those types, casted in similar bronze alloys: the Sassello axes (Franceschi, Del Lucchese, 2006) have 94% copper and 6% tin for the "Neyruz" type and the "Paestum" type; while the Pian del Casale axe has 95% copper and 5% tin (Del Lucchese et al., 1994).

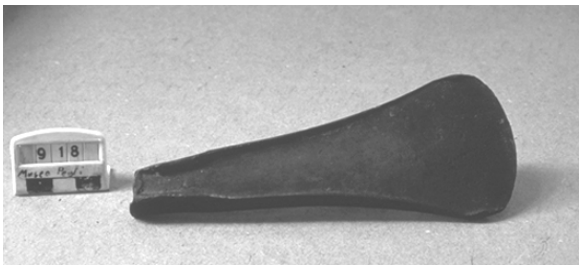

Fig. 4. Axe "Farneto-Scandiano" type from Early Bronze depot of Rocca delle Fene (Savona)

Middle Bronze Age (1600-1350 BC): the first evidence of local bronze metallurgy

All so far presented bronze armlets and tools do not show any proof of local metallurgy and certainly they have been imported from other region. This is the less risky conclusion from the chronotypological analysis.

In the Middle Bronze Age settlement of Bric Tana (Western Liguria internal Mountain), excavated in 1984-89 (Del Lucchese et al., 1998) and occupied by human community from Middle Bronze Age 2 (1500-1450 BC) with cultural affinity to Viverone's culture, 2 metallic drops attached together have been found: one composed of copper from a sulphide mineral, the other composed of bronze. These drops and a tin piece, found in the same occupation phase of the settlement, is the first evidence of bronze production in a settlement in Liguria (Franceschi et al., 1997) and probable exploitation of local sulphide-copper resources. Near the Bric Tana site a little mineralization of bornite has been pointed out (Pipino, 2008).

Late Bronze Age (1350-1150 BC): some evolution in bronze technology

During the Late Bronze Age there was a diffusion of type of structured settlements named "castellari", where the majority of bronze objects of this period have been found. Of particular interest are 2 arrow points and a pin found in S. Antonino di Perti settlement (near the Western Sea coast of Liguria). They all have a high lead content and are made of bronze/lead alloy probably to increase the casting in mould (Franceschi, 2000). The pin is a type with head form by a spindle, typical of the Central European Late Bronze Age (Murialdo, 2001).

In the Bric Reseghe settlement (near the S. Antonino di Perti) other direct metalwork evidence has been found: a raw copper ingot fragment, 2 bronze plate fragments, 1 stone precusor and other metalwork discards (Del Lucchese, 1998b).

In the cave site of Grotta del Galluzzo (near the S. Antonino di Perti and Bric Reseghe) one bronze disk, typologically similar to the circular objects defined as "disk, appliques or phalers" known from many Late Bronze Age sites in Italy and Southern France; and arrow points from the near site of S. Antonino di Perti, show a bronze alloy with high lead content (7% in SEM-EDS analysis) and is an evidence for widespread custom to smelt lead and bronze for the majority of the casting, but also probably diffusion of a new technique of "lose-wax" (Del Lucchese et al., 1994).

Final Bronze Age (1150-850 BC): a rich regional metallurgy between circulation of imported bronze objects and local specialization

The regional situation in the Final Bronze Age, known from more recent finds, is very complete and articulated, mostly with respect to previous periods. In a strictly archaeological aspect the bronze accumulation is known from five bronze depots. The site of Loto in Eastern Liguria, is between the Sea coast and Valle Frascarese where the copper mines of Libiola and Monte Loreto are located. Unfortunately, the aretefacts from that site were lost during World War II. They were an armlet of "Zerba" type, a spear-ferrule, a disk and a copper plano-convex ingot (Issel 1892; Negroni et al., 1979). In Western Liguria a lost depot from Cairo Montenotte (between Padana Plain and the Apennine Mountains) consisted of 40 kg of armlet decorated by curvilinear groups and "chevrons" and belonging to a type typical for the Urnnfield groups of the Elvetic-Rhein area (Tambari, 1994); a bronze depot of Bric del Ciaz (Fig. 5) (near Cairo Montenotte and Sassello) consisted of 3 swords fragments identified as "Arco" type, 3 spears points similar to the types distributed in the North Western Italy, a spear-ferrule, a razor identified as "Scoglio del Tonno" type, a dagger blade and incomplete bronze plate (Gambari et al., 1994).

Fig. 5. Final Bronze Age bronzes depots: left – Bric del Ciaz; right – Bric della Sorte

More recent findings are depots of Bric dei Corvi (inland of the Western Liguria Sea coast), the study of which is in progress, and of Bric della Sorte (Fig. 5) (Western Liguria internal Mountain) (Del Lucchese, Delfino, 2008). This depot is found in a little rock pit near the hill top and consists of 51 raw copper ingots fragments and fragments of 19 bronze objects. Among them there is an armlet "La Poype" type, typical for the Western Alps area in Ha A1/A2 (XII-XI c. BC), a conic button and circulars rings typical for the North Western Italy in the advanced Final Bronze Age (X-IX c. BC), and other objects as a sword blade, two typologically unidentifiable armlet fragments and other tools fragments.

All of the bronze depots, except Cairo Montenotte, are reserves of metal for recycling, located near hilltop positions along important ridge roads and found in little rock pits, composing of destroyed objects of various types.

Along the Western Sea coast is the cave of Sanguineto, utilized from the Neolithic to the Iron Age (Odetti, 2002), where there were "terminal flat" type axe typical for the Final Bronze Age IIIb in Southern France (Ha B2) and a "Nazari" type knife typical for the extremely advanced Final Bronze Age/Early Iron Age in Padana plain (Del Lucchese et al., 1994). From the metallographic analysis it is obvious that they are not complete instruments, there are no signs of use and fusion slavers. A stone mould with the same instrument pair was found near Avignone (Southern France) and is conserved in the local museum (Rossi, 2004): there is an obvious relation with the Ligurian samples.

A typical regional product in the Final Bronze Age was the armlets: that present in different variants in settlements, burials and stray finds. This ornament object puts Liguria in a macroregional metallurgical circle. The armlets found near Bric della Sorte (Del Lucchese, Delfino, 2008), in a stray find near the above discussed metal depot, belong to two types; two with enveloped heads were decorated with engraved oblique spines. As regards to s general enveloped head form, they are close to the armlets types of Renanians Urnfield culture of Ha A1-A2, while for the decoration it is possible to think for a local Ligurian production. At the same site there were other 4 armlets of "La Poype" type, similar to the Piedmont and Savoia Alps samples. In a burial in the carstic crevasse named Buco del Diavolo (Ligurian Western Alps) 8 armlets were found (Lamboglia, 1939) that do not have exact typological comparison; a typical armlet of the Western Liguria (Del Lucchese, 2004), but with possible influences from the "La Poype" type for their shape, while part of the decoration (central "chevron") may be influenced by the "Zerba" type, typical of Eastern Liguria/Apennine Emilia.

A new discovery of different bronze objects in a probable settlement hilltop site of Bric S. Bernardo (near Bric Tana and Bric della Sorte, Western Liguria) confirms the strict connection to the Western Alps metallurgy. The find comprises a "flag" axe similar to axe types typical for the Western French Alps, an armlet fragment "La Poype" type, a sickle fragment of "Herrnbaumgarten" variant 2 or "Auvernier" variant 4 type (Primas, 1986) and fragments of various raw copper ingots.

In an old copper mine of Murialdo "località Pastori" (near Bric S. Bernardo) fragments of various raw copper ingot were found, similar to the others in Bric della Sorte and Bric S. Bernardo. A present copper mineral is from the tetrahedrite-tennantite series, with a bornite as a sulphide primary mineral (Pipino, 2005).

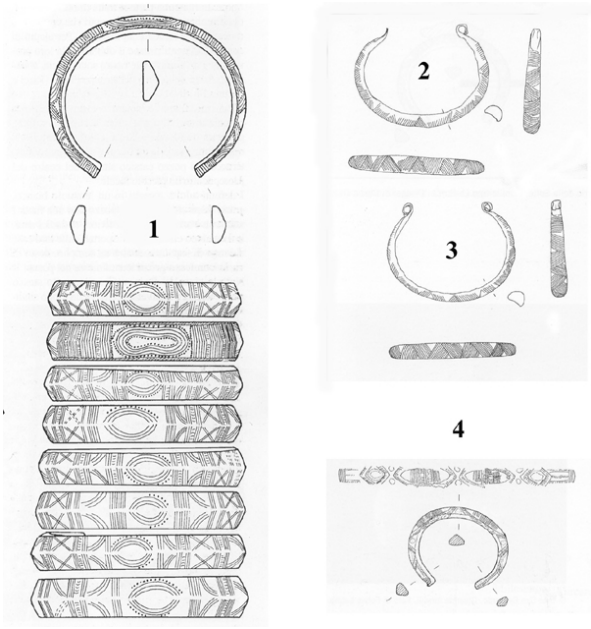

Fig. 6. Armlets from Buco del Diavolo (1), armlets with spines and enveloped heads (2-3) and "La Poype" Type (4) from Bric della Sorte

Unfortunately the archaeometallurgical aspects of the study of this period are poorly developed today, but a study of the raw copper ingots from depots (Bric della Sorte) and a probable settlement (Bric S. Bernardo) is in progress. It started in 2004 and succeeded in finding of a mineral copper type exploited for the melting of these ingots. With the precious collaboration of G. Pipino (Historical Gold Italian Museum of Ovada) the study was conducted with a spectrometry ICP/OES analysis and the results were compared to the local small copper mineralization chemical composition. Having analysed a fragment from Bric S. Bernardo and 4 fragments found in the Murialdo's copper mine, the type and quantity of the traces of minor elements indicate ancompatibility between the mineral copper and the raw ingots (Del Lucchese, Delfino, 2008). In particular, the Bric S. Bernardo copper ingot is relatively rich in silver (0.0428%) and antimony (0.0441%) and poor in lead (0.4517%), that is normal for copper deriving from tetrahedrite-tennantite mineral series, while the high percentage of traces of others elements as tin (0.0080%) proves a derivation from sulphide mineral (Del Lucchese, Delfino, 2008; Pipino, 2008). In the 4 fragments from the Murialdo' copper mine, only two can be chemically linked to Bric S. Bernardo's ingot, owing silver (0.040%) and cobalt (0.046%) percentage.

Another chemical analysis, conducted in collaboration with E. Franceschi and G. Luciano of the Chemistry Department of Genoa University (Franceschi et al., 2004) carried out SEM-EDS analysis of a raw copper ingot from Bric della Sorte. It has shown a derivation from sulphide mineral, precisely bornite, pitiable with copper mineralization of Bormida (near Bric della Sorte, Bric S.Bernardo and Murialdo) (Pipino, 2005).

Fig. 7. A Final Bronze Age's distribution of depots, settlements and copper mines in the Val Bormida area: 1 – Bric S. Bernardo; 2 – Bric della Sorte; 3 – Cairo Montenotte; 4 – Bric dei Corvi; 5 – Bric del Ciaz; copper mines A – Murialdo, B – Bormida, C – Biestro

Some conclusions

From the presented data it is possible to show an evolution from the Copper Age to the Final Bronze Age, from the earliest external connections to latest local development of the metallurgy in Liguria, mostly in the West part.

Copper Age: Western Mediterranean connections

Consequently a metallurgical technique was found in the Castellari di Loano tumulus, that shows a copper awls with a high nickel/antimony percentage and a plate casted with arsenic. It is possible to relate this find to the metallurgy of awls of Sangmeister's copper group 31, known from the West Mediterranean (Sangmeister, 2005). It's not possible to link it to the South-West Iberian Chalcolithic metallurgy which has a low nickel percentage in Iberians objects, it doesn't exceeds 0,59% (Montero Ruiz, 1994). There is a connection to the copper metallurgy of falhertz mineral developed between Northern Italy and the Provence, as shown in various analytical analyses of copper objects (de Marinis, 2006). An arsenical copper metallurgy known from arsenical plate, is surely related to the South-Western Iberia metallurgy, because of comparably in chemical composition and arsenic's percentage with various Chalcolithic Iberian objects (Montero Ruiz, 1994), although it is necessary to verify the present conclusions, by the analyses of the Ligurian sample with the same analytical method (AAS) used for the Iberians samples.

We suggest that the first metallurgy in Liguria, based on objects for which reliable study that connects typological and archaeometallurgical data was possible, had an external impulse from Western Mediterranean. This was a new technology that uses a falhertz mineral or melting arsenic-bearing copper objects in the advanced Copper Age, surely dated by the archaeological contexts (Castellari di Loano and Polera cave with Bell Beaker graveset). Local available copper resources and their exploitation are not documented now in the Western Liguria, but are largely known from the Eastern Liguria by Libiola and most of all Monte Loreto mines.

Bronze Age: a progressive developement of an independent metallurgy set in the inter-regional metallurgical circles

During the Early Bronze Age a great variety of bronze tools from the Italian Peninsula and the Alps area circulate in Liguria. The first evidence for bronze accumulation is the Rocca delle Fene axes depot. Typologically and technologically the artefacts are typical for the advanced Early Bronze Age (Bz-A2) and suggest continuity in the metallurgical melting work from the Bell Beaker period to the initial Early Bronze Age (Bz-A1). A circulation of bronze objects, along with the bearers of these objects, with their metallurgical knowledge, had made of Liguria a region completely at home with the risings metallurgical manifestations that started in the Middle Bronze Age with a progressive diversification of objects and melting techniques (de Marinis, 2000). Major evidence for local metallurgy and its evolution are the bronze and copper drops from Bric Tana.

From the Late Bronze Age onwards, a local metallurgy seems to go in parallel to the progressive metalwork development of other adjacent regions. Some evidence of this developement is the casting bronze technique with lead, visible in many settlement objects, that is similar to the Western Europe Latest Bronze Age (de Marinis, 2001). More metalwork evidence are found in settlements, after the advanced Middle Bronze Age in Bric Tana. The first evidence of a "lose-wax" casting technique is known from the Galluzzo cave that arrived in the Central Mediterranean from the Near-Eastern Mediterranean through the Ciprum-Sardinia contacts in the Late Bronze Age (Giardino, 1998). Much more secure is the hypothesis for local metallurgy in the Final Bronze Age; characterized by relatively large scale bronze accumulation of destroyed objects for recycling (four “wreck” depots). This is also the time of the first elaboration of local objects that is based on object typology typical for the Renanians Urnfield culture and the Final Bronze Age in Eastern France. Other objects are much more similar to axes and armlets from the Western Alps and this puts Liguria entirely in the peripheral sphere of the Western Alps metallurgical Circle (Bocquet, Lebascle, 1983). A great concentration of bronze depots and objects, mostly raw ingots, is found in the Western Liguria Mountain area between Valbormida and Sassello; in the same area there are various small copper mineralizations that according to the chemical and mineralogical analysis indicate a connection between the protohistorical raw copper ingots and the locals copper mines. A resume of all the data, which is in a process of completion, shows a local metallurgy independently forming a metalwork area in the Western Liguria with the exploitation of the local copper resources.

Limit of research

The techniques of archaeometallurgical analysis used in old studies need to be revised and uniformed under the new techniques. A review of the copper and bronze objects with more adequate analytical methods is also needed. The provenance of raw material should be explored by ICP/OES or AAS instead of XRF or SEM-EDS method; not only for finished objects, but for example, for raw copper ingots found in archaeological context. The study of the exploitation of copper

resources is still in progress and the presented view is preliminary. A programme for territorial research to locate exactly the copper mineralizations is needed, as well as excavations of archaeological sites where a bronzework evidence was found, mostly in Val Bormida area.

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