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A multidisciplinary approach about study of Orgères's metal finds (La Thuile, Aosta-Italy): archaeological excavation and XRF analysis.

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Abstract – **Characteristic of Alpine settlements is the low percentage of metal finds and it's very important to know the different metals (or metal alloy) used to produce the objects and XRF it's the handheld and mobile instrumentation more suitable for this purpose.**

I. INTRODUCTION

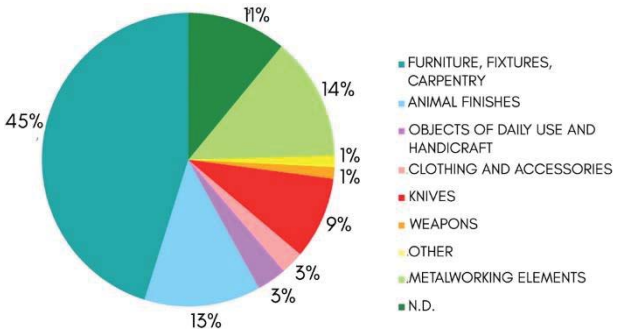
The archaeological excavation of Orgères is located at 1665 m. of altitude in the Vallon des Chavannes, along the road from La Thuile to Tarantasia (France) which represents an alternative to the Piccolo San Bernardo pass; moreover, it is located on the way to the Val Veny (Courmayeur) (fig.1).
Its strategic position and economic resources are the reason to the settlement continuity between the 1st century AD to the 18th century [1].
A characteristic of the Alpine excavations is the minimum percentage of archaeological artefacts: for the metal finds, it must be remembered, the uncertainty of the percentage data depends on their remelting and / or reuse to be connected to the high costs of the different production phases (extraction, reduction and forging) generally carried out by specialized craftsmen [2].
Furthermore, when good ergonomics have been obtained, the morphology of the objects is not changed: for this reason it is difficult to create a precise chronological framework.

We present the first classification of metallic everyday objects offering an important comparison for similar researches in the Alpine area [3-4].

Fig. 1. Settlement of Orgères (La Thuile-AO) and vallon des Chavannes; XRF analysis on the archaeological site; lower right location of La Thuile area (S. Pinnacoli, RAVA).

II. ARCHEOLOGICAL RESEARCH: METHOD

Firstly we proceeded to a morpho-typological subdivision of the 157 archaeological finds, based mainly on bibliographic comparisons (Graph 1; Fig. 2).



Graph 1. Morpho-typological suddivision (G.Lupano).

The result is an articulated typological classification: what do the objective data show?

The most numerous artefacts have been included in categories that we can define as 'essential' for a mountain settlement (Fig. 3): building, carpentry, window frames and interior furnishings (hooks, mounting brackets, buildings nails, furniture nails, foils, keys, handles and handholds etc.). Below are some examples of harnes for animals that are indispensable not only for food needs but also for carriage of goods (plenty of shoeing nails, also "for ice") or, about sheep and goat breeding, for the production of wool, skins, milk and cheeses.

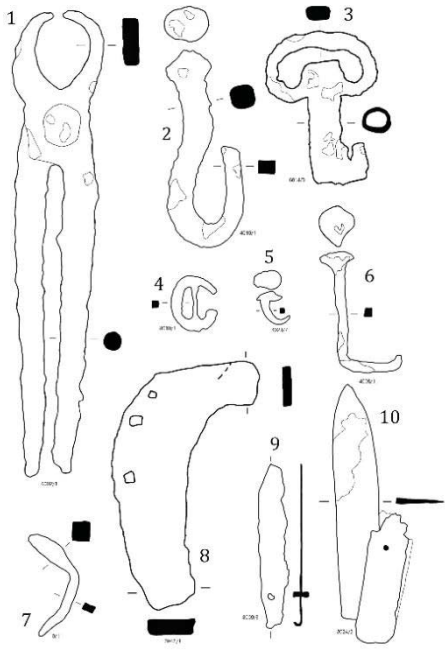


Fig. 2. Reliefs in 1: 3 scale. 1) pincer 2) hook 3) key 4) buckle 5) stud 6) riveted nail 7) shoe nail 8) horseshoe 9) wooden knife 10) switchblade knife (G.Lupano).

The self-sufficiency of the settlement is emphasized through the percentage of objects used both for metalworking – for example the double-valve stone matrix (Fig. 4), the pincer and some slags - and agricultural activity (billhooks, perhaps sickles etc.).

The knives are well represented because, considering their multifunctional, they were indispensable objects of daily life; sewing needles and thimbles are less numerous; the gimlets and small knives to finish and carve small wooden or bone objects (in the archaeozoological study, bones with traces of craftsmanship were selected [5-6-7]); the buckles and clothing accessories. Unfortunately, a relatively significant percentage is represented by artifacts that cannot be identified because very degraded.

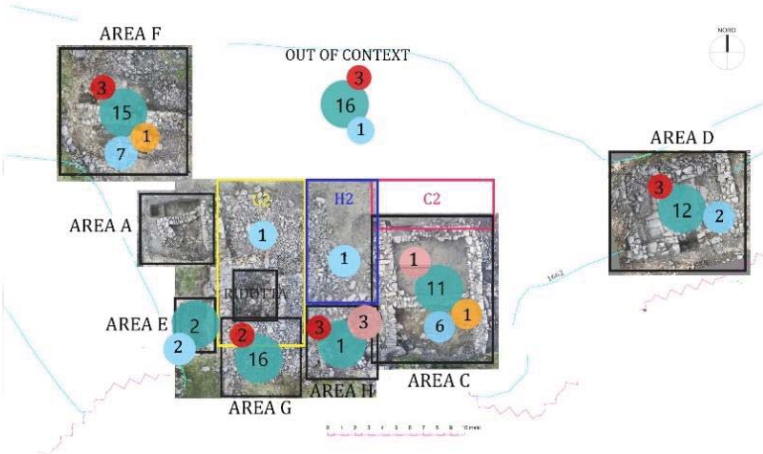


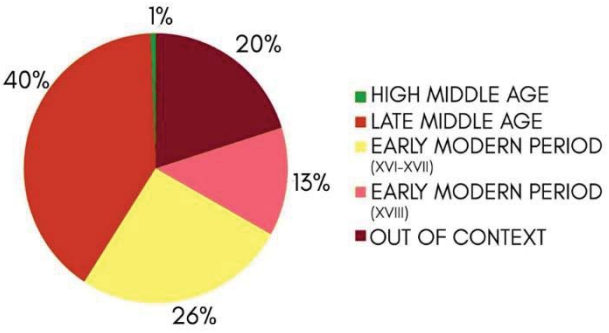
Fig. 3. Distribution of metal finds.

Fig. 4. Double-valve stone matrix

III. ARCHAEOLOGICAL RESULTS

The functional classification, based on the morphology of the object, allowed some working activities to be hypothesized: the most common were construction and forging; the latter probably is located in a specific area (zone F) within the settlement.
Metal products, with data relating to ceramic mixtures [8] and archaeozoology [5-6], are important to reconstructing the daily life of an alpine settlement whose existence was based on the valley economy (milk, wool, skins, cheeses etc.) which guaranteed not only self-sufficiency, but also a good commercial activity linked to the control of the roads towards the Val Veny and the Col des Chavannes.

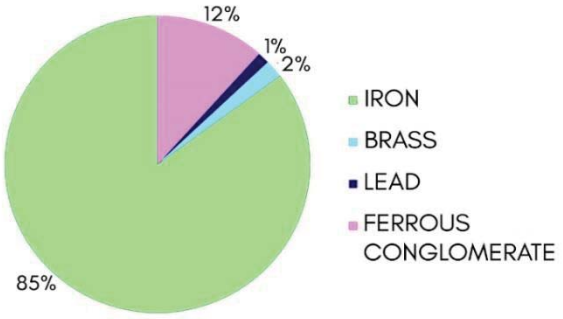
The dating of the finds was based both on the data obtained from archaeological stratigraphy and on the comparison with other contexts: the most significant percentage of metal finds is included in the late medieval age (mid-13th-late 15th century), a period of particular recovery economic of Orgères represented by the construction of a fortified house (casaforte), by an animal shelter and by a greater monetary circulation (two coins of the bishop of Mantova dated to the13th-14th century and one coin of Amedeo VIII, 1416) (Graph 2).



Graph 2. Chronological periodisation (G. Lupano).

IV. XRF: METHOD AND RESULTS

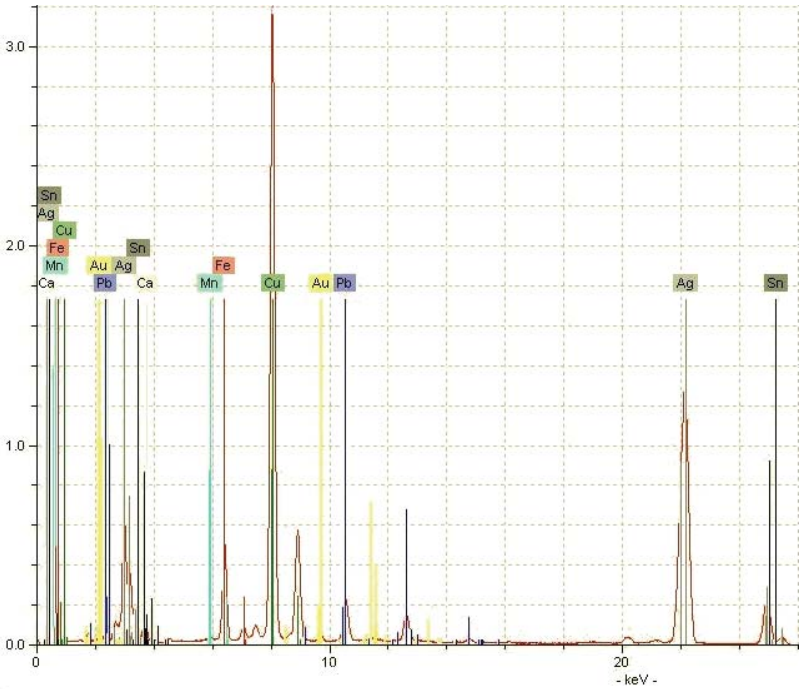
The discrimination based on the different metals (or metal alloy) used to produce the objects, suggested a further functional difference based on the mechanical characteristics typical of a specific material: 97% of the finds were macroscopically examined, without the contribution of more specific chemical analyzes, necessary to define the precise chemical composition; 86% of finds are made of iron (Graph 3).



Graph 3. Discrimination based on different metals (G.Lupano).

The study of metal artifacts through non-invasive and micro-destructive investigations can provide an important contribution to the archaeological research for precisely interpreting past evidence. By investigating the composition of the objects and simultaneously identifying trace elements it is possible to obtain information about the alloy used and the origin of raw materials.
Furthermore, metallography allows to know the crystalline microstructure of metals and alloys, highlighting their characteristics and defects and recognizing production technologies [9].

Thus, the analytical approach on metal artefacts should become a consolidated practice, from the discovery until the musealisation of the object, being functional not only for the knowledge of the material but also for its proper conservation.



Graph 4. Coin XRF spectrum: the peaks of copper and silver are evident.

Metal finds coming from the Orgères site were investigated with a portable X-ray fluorescence spectrometer (XRF) directly on the archaeological site. It is a semi-quantitative and non-destructive technique which uses an X-ray beam to stimulate a fluorescence phenomenon in the material, whose energy is characteristic for each chemical element which is in this way identifiable.
Although it is not possible to detect light elements (from hydrogen to sodium) and, as a consequence, to analyze organic evidence, the XRF investigation is gaining importance in the field thanks to some essential characteristics: sampling is not required, artefacts preparation, when needed, is minimal and data collection is fast [10].

However, it is worth to specify that X-rays have a penetration capacity which depends on the atomic number of the elements inside the sample and, in some metals, it can reach a depth of 20 μm.

Therefore, in the case of *in situ* investigation, the obtained results may not exactly reflect the real composition of the artefact, due to the presence of a surface oxidation patina or excavated ground residues [11-12].
In the introduced work, a fire striker, a ring with a *cabochon* of glass paste, a slag and a coin (dating to the early Middle Age) and a bullet were chosen for the *in situ* XRF investigation.

The results immediately shown that the fire striker and the ring were made with a copper and zinc-based alloy (brass), whereas the coin of Amedeo VIII (1416 A.D.) was forged with a silver and copper alloy (Graph 4).
The bullet and the slag had a high percentage of iron with a variable amount of manganese: for the slag, the comparison among XRF analysis, the information obtained from the literature [13] and the geological-surveys [14] can provide some hints on the origin areas of raw materials and, therefore, on the management of resources.

This case study has demonstrated how the ordinary *in situ* application of this analytical method allows to obtain important information about finds, for a better interpretation of archaeological data.
This procedure is suggested to show how an integrated scientific-humanistic approach let achieve in depth results that can permit a better fruition of acquired knowledge.

Orgères is an alpine settlement, therefore the presence, for the late medieval period, of objects that are outside the economic-productive activities is striking: a flint, a small ring with *cabochon* glass paste, double oval buckles and buckles made of brass, an alloy particularly "precious" index of good economic level.
The systematic increase of this scientific approach in the field is desirable.

HEADINGS

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