



## CONTRIBUTION OF RADIOCARBON DATING TO THE CHRONOLOGY OF ENEOLITHIC IN CAMPANIA (ITALY)

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**Abstract:** The paper presents new and important <sup>14</sup>C data from eight Eneolithic sites in Campania measured at the Centre for Isotopic Research of Cultural and Environmental Heritage (CIRCE) AMS laboratory in Caserta (Italy). Twenty-four <sup>14</sup>C determinations on bone and charcoal are used here for chronological reconstruction of human habitation and dating of some volcanic eruptions affecting the settlement activity. Our research has shed new light on absolute chronology of the whole Campanian Eneolithic, a period of profound cultural transformations triggered by introduction and use of metals, in particular copper.

**Keywords:** Eneolithic, chronology, radiocarbon dating, archaeological cultures, eruptions

### 1. INTRODUCTION

Campania is a region in southern Italy (regional capital Naples) with abundant evidence of pre- and protohistoric habitation. Its geomorphology is characterized by volcanic complexes like Somma-Vesuvius and Phlegrean Fields, whose eruptions acted as agents of landscape formation with a positive impact on soil fertility. Excavations in Campania have yielded many sites buried below large amounts of stratified pyroclastic deposits of a number of Phlegrean and Vesuvius eruptions. While on the one hand the volcanic activity favoured farming and development of human habitation, on the other it caused catastrophic destructions.

The Metal age in Europe started with the Copper Age, which is in Italy more usually termed Eneolithic (from Latin *aes*, copper). The term Eneolithic (ca 4000-2300 cal BC) emphasizes introduction of first metal objects and their use along with stone implements. The period is characterized also by other technological innovations, from which ensued a better land exploitation and demographic increase. In Campania, the Eneolithic period is bracketed between the Neolithic Diana culture and the earliest Bronze Age. There are two principal Eneolithic

cultures in Campania – Gaudio and Laterza. The earlier one, **Gaudio** culture (from Gaudio cemetery, few kilometres from Paestum, Salerno), represents the Middle Eneolithic. The Gaudio culture was spread also in Calabria, Basilicata, Molise, and southern Lazio. The later one, **Laterza** culture (from Laterza cemetery, near Bari), represents the Late Eneolithic. Apart from Campania, Laterza culture was present also in Lazio, Puglia, and Basilicata.

Recent investigations in Campanian provinces Avellino (AV), Naples (NA), Caserta (CE), and Salerno (SA) have allowed archaeologists to identify new sites and cultures, which better characterize regional Eneolithic. Above all, the recognition of a new culture, named **Taurasi** (after a cemetery excavated in Taurasi near AV) that is attributable to the Early Eneolithic must be seen as a significant achievement. Other cultures, albeit not that clearly distinguishable by now, have been defined as well; one of the oldest, Macchia a Mare-Spatarella culture, is referable to the transition from the Late Neolithic to Early Eneolithic. The recent excavations have also investigated close relationship between several Eneolithic sites and the coeval volcanic eruptions. In this respect the Phlegrean eruptions Agnano 3 and Paleoastroni 2, which covered a lot of Eneolithic settlements, represent important chronostratigraphic markers (Talamo, 2008a and 2008b).

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Accordingly, the current state of things presents favourable conditions for a reconstruction of complete chronological and cultural sequence of Eneolithic in Campania. Albeit the most of recent excavations have not been brought to the public in full, the published information are sufficient to describe cultural and stratigraphic position of the finds. However,  $^{14}\text{C}$  dates until recently available have been very few and from various sites and contexts (S. Maria dei Bossi: Albore Livadie and Gangemi, 1988; S. Antonio di Buccino: Holloway, 1973; Gaudo: Bailo Modesti and Salerno, 1998).

Having been spurred by the recent important discoveries, the aim of our work is to produce new absolute chronological evidence for Eneolithic in Campania and several volcanic eruptions with impact on excavated settlements below presented. In fact, the extended  $^{14}\text{C}$  data set – which we bring for the first time here – worked by the Bayesian tools is intended to make a fresh contribution to the research of cultural-chronological development of the period. Further, it is to enhance the dating resolution of some eruptions, which influenced human habitation in the region.

## 2. MATERIALS AND METHODS

In order to investigate absolute chronological questions, charred wood, seeds, and bone samples were collected from different archaeological sites dated to the Early, Middle and Late Eneolithic.

All the samples were prepared for AMS  $^{14}\text{C}$  dating at the CIRCE laboratory in Caserta (Campania, Italy). They were chemically treated to isolate the carbon fraction and eliminate contaminants. For charcoal and seeds, the AAA (Acid-Alkali-Acid) protocol was used (Mook and Streurman, 1983). Bones were chemically treated in the CIRCE radiocarbon sample preparation laboratory using collagen extraction protocol (Longin, 1971; Stafford *et al.*, 1987) modified with the addition of basic treatment (NaOH) (Arslanov and Svezhentsev, 1993; Piotrowska and Goslar, 2002) in order to eliminate humic contaminants. For comparison, five samples were prepared in the Research Laboratory for Archaeology and the History of Art in Oxford using routine collagen extraction procedures, with an additional ultrafiltration step to purify the bone gelatine (Brown *et al.*, 1988; Bronk Ramsey *et al.*, 2004).

After the chemical pre-treatment, samples together with copper oxide grains were introduced in quartz tubes, which were evacuated and sealed and then combusted in muffle furnace at  $920^\circ\text{C}$  for 6 hrs. After combustion, the produced  $\text{CO}_2$  was purified in a cryogenic line and reduced to graphite either by the Bosch reaction using Fe as catalysts in a multisample graphitization line (Passariello *et al.*, 2007) or by a Zinc reducer using Fe as catalysts (Marzaioli *et al.*, 2008). Then, graphite targets were measured by the CIRCE AMS system in Caserta (Terrasi *et al.*, 2007; Terrasi *et al.*, 2008). Note that, in this work, all radiocarbon dates are shown by our Lab index (CIRCE-DSA/DSH), because the measurements were done by the CIRCE AMS system. The dates from the literature, shown in the figures, are accompanied by references. The obtained radiocarbon ages were calibrated

using OxCal program (Bronk Ramsey, 2001), considering INTCAL04, the calibration curve acceptable for the calibration of all analysed samples (Reimer *et al.*, 2004).

## 3. RESULTS AND DISCUSSION

This study is the first work in Campania, which investigates a whole period of Eneolithic by the series of  $^{14}\text{C}$  dates analyzed by means of Bayesian chronological models. The  $^{14}\text{C}$  dates in models are organized according to proven or postulated real-time relations between individual determinations. The real-time relations are derived from physical-stratigraphical observations between  $^{14}\text{C}$  samples and from outcomes of complex archaeological relative-chronological investigations.

Results are presented and discussed following the archaeological relative chronology of sites dated to the Early, Middle, and Late Eneolithic. The subdivision in three periods was made according to the cultural sequence characterized by archaeological artifacts (mainly potteries) and, afterwards, confirmed by absolute dates obtained in this work. All the sites with ascribed archaeological period and number of dated samples are listed in **Table 1**.

### Chronological investigations of Early Eneolithic

#### - San Martino – Taurasi (Avellino)

The most important result of 1993-1996 archaeological excavations of San Martino, a site on the Taurasi hill, is a discovery of unique Early Eneolithic evidence until then without comparisons elsewhere. Apart from Eneolithic, the site was occupied in the Early Neolithic (“Ceramica Impressa” culture settlement), the Late Roman period and the Early Middle Ages. It also has yielded traces of rural settlements on soil above the “Avellino” pumices (1935-1880 BC; Passariello *et al.*, 2009).

The Early Eneolithic evidence unearthed at San Martino – Taurasi represents five structures of special purpose. They were of trapezoidal or apsed shape with low dry-stone walls or only postholes. Around these structures and on or below associated walking horizon a lot of cremation tombs appeared. The construction elements of these structures together with a number of pottery and objects indirectly connected to the tombs reinforce the idea that the five buildings were related to the cult of the dead, served as tomb shelters and not as dwellings.

**Table 1.** Investigated sites with their archaeological period and number of samples dated.

Sites	Historic period	Sample number
S.Martino (Taurasi, Avellino)	Early Eneolithic	4
S.Maria dei Bossi (Casalbore, Avellino)	Early Eneolithic	5
Piano di Sorrento (Napoli)	Middle Eneolithic	1
Caivano (Napoli)	Middle Eneolithic	5
Sala Consilina (Salerno)	Middle Eneolithic	4
Mirabella Eclano (Avellino)	Middle Eneolithic	2
Gricignano d'Aversa (Caserta)	Late Eneolithic	2
Atena Lucana (Salerno)	Late Eneolithic	1

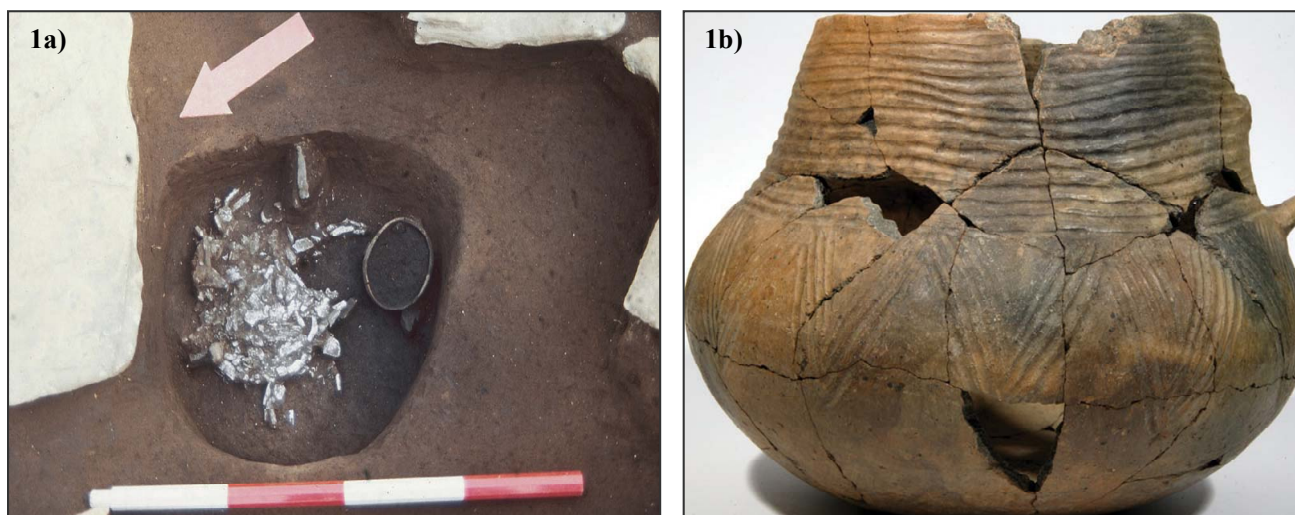


Fig. 1. a) Cremated bones with a cup and a copper dagger from a tomb in Structure 3. b) A jug from Structure 1.

Until now, the Taurasi tombs are the most ancient Italian cremations deposited in distinct tombs. In S. Martino, the dead body together with grave-goods was cremated in a place different from the place of burial. Cremation remains were collected and directly deposited in the grave pits or vessels, which were put in the graves. For the first time, double burials occurred and one or more of the deceased were accompanied by specially cremated animals. The scarce copper finds – a dagger and a pin from the same tomb – indicate that in the time of Taurasi tombs metal was rare and highly valued (Talamo, 2004). All the structures and the tombs are referable to a distinctive archaeological phase of Eneolithic. For its distinctive characteristics, namely cremation ritual and the specific pottery (Fig. 1a-b), this culture was called “Taurasi”. According to  $^{14}\text{C}$  dating, Taurasi culture precedes the Gaudio and Laterza tombs (Talamo, 2004).

For  $^{14}\text{C}$  dating were submitted charcoals from Tomb 3/1 (Structure 3) and Tomb 4/1 (Structure 4), which covered the graves, and from Tomb 2/9 (Structure 2) and Tomb 5/4 (Structure 5), both probably from funerary pyres. The radiocarbon data are presented in Fig. 2.

When calibrated using vague priors (Buck *et al.*, 1996), the majority of age ranges are distributed in the interval 3500-3300 cal BC. However, as a consequence of the characteristics of archaeological charcoal  $^{14}\text{C}$  samples, the measured  $^{14}\text{C}$  dates represent *termini post quem* and not *termini ad quem* for the investigated interments. The obtained age ranges give the time of growth of the dated tree rings and therefore a time lag is to be assumed between the obtained and the pursued dating information. Even if the time lag would be large (e.g. 200-300 calendar yrs), the Taurasi tombs would still clearly precede those of Gaudio and Laterza cultures. Given that we do not know from which part of log originated the charcoal samples measured, we chose to interpret these dates in a widest way.

- Santa Maria dei Bossi - Casalbore (Avellino)

In Santa Maria dei Bossi, a site few km from the modern village Casalbore, archaeological excavations in 1985 unearthed a sequence from Early Neolithic (“Ceramica Impressa” culture settlement) to the Roman times.

For our study, the Early Eneolithic cemetery consisting of several tombs is of importance.

The tombs, which may have contained inhumations and have yielded pottery and lithics (weaponry), represent a not clearly identifiable culture of the Early Eneolithic. Such archaeological classification corroborated the acquired  $^{14}\text{C}$  evidence. The first  $^{14}\text{C}$  date from this site measured in France on charcoal from one of the tombs yielded  $4800 \pm 90$  BP (Albore Livadie and Gangemi, 1986; OxCal v3.10 and INTCAL04 give at 68.2% confidence level 3660-3510, 3430-3380 cal BC, at 95.4% 3770-3360 cal BC).

In 2006, new  $^{14}\text{C}$  dates on new samples from the Santa Maria dei Bossi – Casalbore tombs were measured in the CIRCE AMS laboratory in Caserta. The results are shown in Fig. 3, as ranges of calibrated  $^{14}\text{C}$  ages, together with the only date in the literature. The  $^{14}\text{C}$  age of the oldest samples are in agreement with the previous dating ( $4800 \pm 90$  BP; Albore Livadie and Gangemi, 1986).

### Chronological investigations of Middle Eneolithic

The Middle Eneolithic in Campania is characterized by the important Gaudio culture. This culture is known solely from the cemeteries, that complicates investigations of its absolute chronology. The tombs usually contain collective burials with inhumations buried in small chambers cut in soft rock (tuff or travertine), which were entered from an access well or shaft.

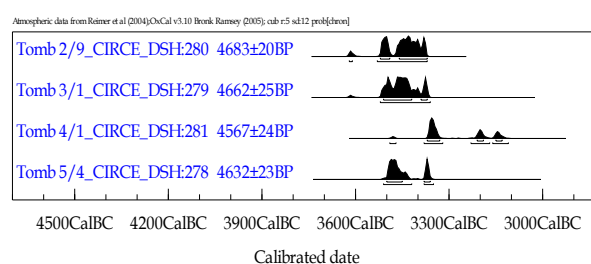
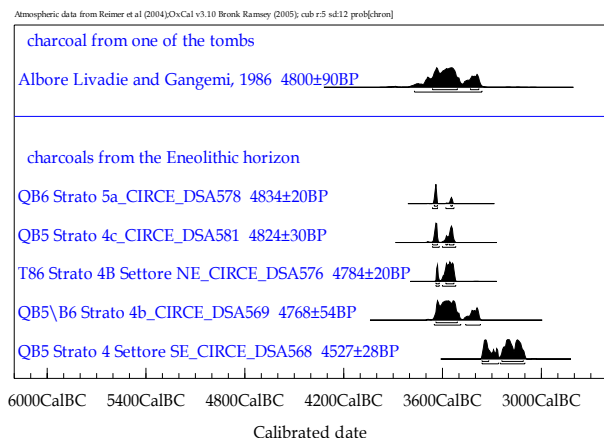


Fig. 2. OxCal calibration of  $^{14}\text{C}$  ages measured on 4 charcoal samples from tombs of the Taurasi site.



**Fig. 3.** Calibration and comparison of results obtained in the present work for samples coming from S.Maria dei Bossi and the only date known in the literature.

However, excavations carried out over the past 20 years have exposed some settlements and cemeteries, which seem to be different from the sites of Gaudo culture as known by now. In order to investigate the absolute chronology of Middle Eneolithic, a settlement at *Caivano* (NA) and three cemeteries, namely *Piano di Sorrento* (NA), *Sala Consilina* (SA), and *Mirabella Eclano* (AV) have been investigated.

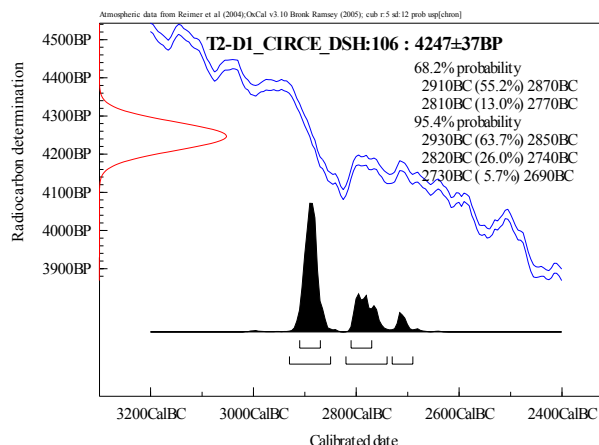
- *La Trinità – Piano di Sorrento (Naples)*

Building works in 1987 in La Trinità – Piano di Sorrento exposed five typical graves with a large amount of pottery. According to decorated pottery and typology of tombs, the burials belong to Gaudo culture. The relative chronology of the site (Albore Livadie, 1991) suggests that the graves 5, 4, and 3 belong to the ancient phase, grave 1 to the recent phase, and grave 2 to the intermediate phase. In 1993, pottery from two graves was dated by thermoluminescence (TL). The measurements, which gave for grave 1 2550±380 BC and for grave 4 2350±190 BC (weighted average of three dates), were executed by The Physical Science Department of the University “Federico II” of Naples and CRIAA, Bordeaux, France (Vartanian *et al.*, 2001).

In 2005, we obtained several bones from the Piano di Sorrento inhumations. Bones proved to be much degraded, with a very low content of or no collagen. Only two samples (from grave 2), chemically treated in the Research Laboratory for Archaeology and the History of Art of Oxford using collagen extraction protocol with an additional ultrafiltration step, yielded sufficient collagen for dating. However, from these two samples one was rejected because of its large standard error. In **Fig. 4**, we report the result for the remaining sample.

The above discussed  $^{14}\text{C}$  dates of human bones and the TL dates of pottery from the literature represent the absolute chronological information about the Middle Eneolithic, particularly of Gaudo culture. Considering all dating results, it is DSH106 with its small error, what gives the best estimate of absolute date for the cemetery (2910-2870 cal BC; 55.2% on 68.2% probability; 2930-2850 cal BC; 63.7% on 95.4% probability; see Fig. 4)

- *TAV - IV sottotratta - Lotto 10 - Caivano (Naples)*



**Fig. 4.** Calibration of the radiocarbon age of a bone sample from pit grave 2 of Piano di Sorrento. Sample was chemically treated at Oxford laboratory and measured at CIRCE AMS system.

By now, Caivano is the first known Eneolithic village in Campania. The site discovered in 2005 was occupied over a large period in the Middle Eneolithic. However, assignment of the Caivano settlement to one of the regional Eneolithic cultures is complicated by the fact that until this discovery Campanian Eneolithic has been known solely from the cemeteries.

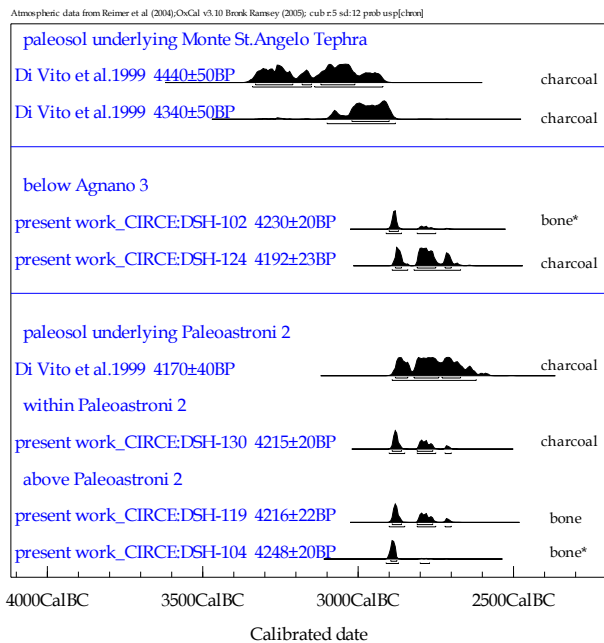
The first observations and studies of the pottery have shown that in the material culture from Caivano there are some analogies with Gaudo or maybe Taurasi cultures, and that it seems to precede Laterza culture. The Caivano settlement with its two phases is exceptional also from the point of volcanic chronostratigraphy. The first phase of this village is directly buried by the Agnano 3 Phlegrean eruption. The second one is included between Agnano 3 and Paleoastroni 2, both below Agnano Monte Spina eruption (4130±50 BP, de Vita *et al.*, 1999).

The absolute chronology of these eruptive depositions has not been conclusively solved, because only few indications, especially for Agnano 3, have been at hand. In fact, we only have a suggestion on its chronology from  $^{14}\text{C}$  dates on charcoals coming from paleosol and thin humified layer, both underlying Monte St. Angelo Tephra (4440±50 BP; 4340±50 BP, Di Vito *et al.*, 1999), an eruption that happened after those of Cigliano and Pignatiello, all later than Agnano 3.

Accordingly, the Caivano settlement is important for absolute-chronological identification of these two eruptions (Agnano 3 and Paleoastroni 2) by means of radiocarbon dating of organic samples extracted from layers buried by the eruptions. In order to better determine the chronology of this site, charcoal and animal bone samples were collected from pits or hearths below the Agnano 3 eruption (i.e. Caivano settlement phase I) and within and above the Paleoastroni 2 eruption.

In **Fig. 5**, one can see the OxCal calibration of  $^{14}\text{C}$  dates obtained in this work together with the results from the literature.

The DSH102 and DSH124 samples (4230±20 BP, 4192±23 BP; 2900-2700 cal BC, 68.2% probability; 2910-2670 cal BC, 95.4% probability) give a *terminus post quem* for Agnano 3, while Paleoastroni 2 is identi-



**Fig. 5.** Calibration and comparison of results obtained in the present work and other radiocarbon ages obtained in the literature. Our samples (CIRCE:DSH-102, 124, 130, 119, 104) were collected above Agnano 3 and within and above Paleoastroni 2. \*Bone chemically treated at the Oxford laboratory.

fied by DSH130, DSH119, and DSH104 samples (**4215±20 BP**, **4216±22 BP**, **4248±20 BP**; 2895–2760 cal BC, 68.2% probability; 2910–2700 cal BC, 95.4% probability). Concerning Paleoastroni 2, the new dates are in agreement, within errors, with the date known until now. The radiocarbon dating of Agnano 3 is very close to Paleoastroni 2. Both eruptions are placed at the beginning of the 3<sup>rd</sup> millennium cal BC, which is a period of intense and frequent activity of the Phlegrean Fields. It should be borne in mind that, in the Phlegrean stratigraphic area, three eruptions have been identified between Agnano 3 and Paleoastroni 2. To the already mentioned Cigliano-Pignatiello and Monte St. Angelo, Paleoastroni 1 (Di Vito et al., 1999) has to be added.

Analysis of the data has been made by the Bayesian tools of OxCal, namely as interval in the sequence of the two eruptions. The resulting overall agreement index (40%) was below the suggested tenability level. This indicates that, within experimental errors, the interval is compatible with 0.

To sum up the results of new <sup>14</sup>C chronology for Caivano, the Agnano 3 eruption, the re-settlement of the site and its destruction by Paleoastroni 2 are likely to have happened within a relatively short time-span almost certainly not exceeding 100 years.

#### - *Capo la Piazza - Sala Consilina (Salerno)*

Recent archaeological excavations at Sala Consilina have exposed a site with two different phases. The first phase is represented by structures with dry-stone walls and a small number of cremation tombs inside pots of Taurasi culture.

The second phase is a Middle Eneolithic cemetery with inhumation pit graves. As for artefacts, the inhumation

graves at Sala Consilina have yielded only pottery, which is not attributable to any archaeological culture known in Campanian Eneolithic. Apart from that, no other diagnostic elements appeared.

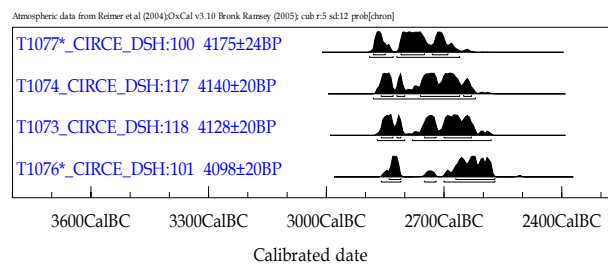
To investigate the second phase of this site (Sala Consilina II), bones coming from four inhumation pit graves were analysed. The radiocarbon ages obtained and calibrated by OxCal v3.10 are shown in **Fig. 6**.

Unlike Piano di Sorrento and Caivano, ranges of calibrated <sup>14</sup>C dates from the second phase of Sala Consilina reflect the plateau-like portion of the calibration curve in the first half of the 3<sup>rd</sup> millennium cal BC. Accordingly, absolute dates for the Middle Eneolithic inhumations at Sala Consilina accompanied with the pottery are to be found somewhere between 2900 and 2500 cal BC.

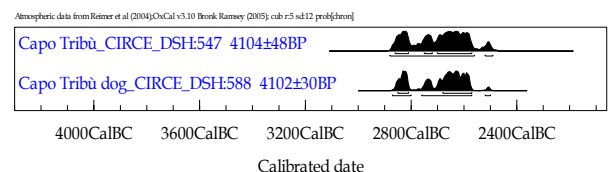
#### - *Madonna delle Grazie - Mirabella Eclano (Avellino)*

The Madonna delle Grazie necropolis at Mirabella Eclano is the second most important necropolis of Gaudio culture after the eponymous site. The site was unearthed in the 1950s. Unfortunately, at present only few artefacts securely associated with archaeological contexts are known. The most important and best preserved tomb of the cemetery is the so-called *Capo Tribù* (chieftain) tomb. Here, a supine man was buried together with his dog and a rich assemblage of weapons, which indicate his importance. This tomb is a unique example within the whole evidence of Gaudio culture and therefore it was selected for <sup>14</sup>C dating.

The bones of deceased and bones of dog from the *Capo Tribù* tomb were analysed in 2008. The results in **Fig. 7** show that both <sup>14</sup>C dates are calibrated against a plateau-like portion of the calibration curve between 2900 and 2500 cal BC. These new absolute dates are further contribution to the debate about duration of Gaudio culture.



**Fig. 6.** OxCal calibration of bone samples coming from four pit graves of Sala Consilina. \*Bone chemically treated at the Oxford laboratory.



**Fig. 7.** OxCal calibration of two bone samples found in the Capo Tribù tomb at Mirabella Eclano (AV). The result corroborates the archaeological observation that both the human and the animal were buried together at the same time.

### Chronological investigation of Late Eneolithic

#### - US Navy "Forum" area - Gricignano d'Aversa (Caserta)

A large-scale excavation of a site in the area of US Navy logistic centre near Gricignano d'Aversa is one of those triggered by the recent large infrastructural projects in Campania.

In Gricignano, evidence of anthropic activity has been identified between the deposits of the Agnano-Monte Spina and Avellino Pumices. Meticulous investigation of so-called "Forum" area has exposed, between the deposits of Agnano-Monte Spina and Phlegrea 1, a large settlement with several apsed houses and two cemeteries with inhumations of a distinctive typology (Fugazzola Delpino *et al.*, 2003). The settlement and the cemeteries, which might be of a just later date, are entirely referable to **Laterza** culture.

Prior to the discovery of Gricignano, typical materials of this culture were already known in Campania, as the Pontecagnano and the Castel Baronia sites (Gangemi, 1988; Talamo, 2006). However, the absolute chronology of Laterza culture has not been much clear.

Archaeological importance of the evidence from Gricignano resides in the fact that it illuminates transition between Late Eneolithic and the incipient Early Bronze Age represented by Palma Campania culture. Hence, research of interrelations between Laterza and Palma Campania cultures will contribute to the understanding of emergence of the Early Bronze Age in Campania.

Environmentally, the transition period is characterized by several eruptions of Somma-Vesuvius and Phlegrean Fields. Between the two big eruptions (Agnano-Monte Spina and Avellino Pumices) there were four Phlegrean Fields eruptions (Phlegrea 1, 2, 2 bis, 3). These were of small environmental impact, but in turn stimulated human habitation and triggered an intensive agrarian exploitation.

Accordingly, the  $^{14}\text{C}$  dates from Gricignano provide also fresh data for the volcanic chronostratigraphy.

To investigate the absolute chronology of the "Forum" area at Gricignano, charred seeds from a storage pit cut into the paleosurface just on the top of the Agnano-Monte Spina level and sealed by the Phlegrea 1 eruption were collected. The results of DSH125\_US2315-2254 and DSH126\_US2315 samples are shown in **Fig. 8**, together with the only date present in the literature.

These new data give an upper limit for the chronology of Agnano MS and a lower limit for Phlegrea 1.

#### - Fosso Aimone - Atena Lucana (SA)

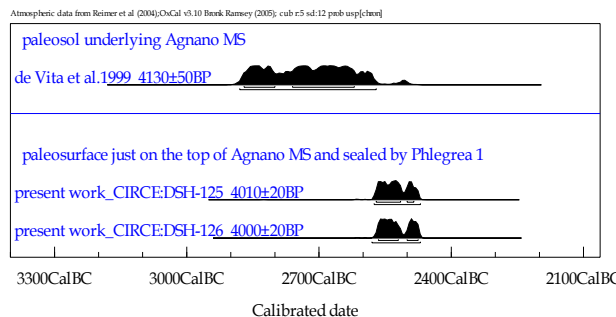
Recent archaeological excavations in Atena Lucana near Salerno uncovered an area of the craftsmanship production, referable to the transition period of Late Eneolithic – Early Bronze Age. Even if some cultural aspects are similar to Laterza, it is culturally almost pure context related to **Çetina** culture.

A charcoal coming from a hearth of this site supplied useful information about the Eneolithic – Bronze Age transition (see **Fig. 9**). Radiocarbon age of sample, with calendar age interval of **2470-2270 cal BC** (60.1%, on 68.2% probability), dates the site to the second half of the 3<sup>rd</sup> millennium BC.

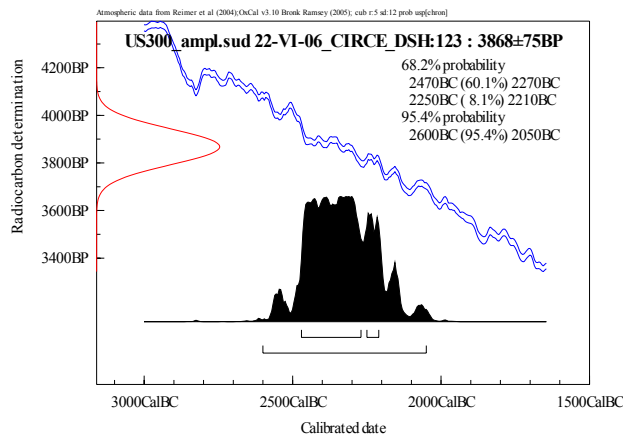
## 4. SUMMARY AND CONCLUSIONS

The presented 24 newly measured  $^{14}\text{C}$  dates from eight sites provide the largest published radiocarbon data set for Campanian Eneolithic. Covering the entire period, they have enabled comprehensive and conclusive investigations not only into well-known cultures. The new data have also strongly contributed to the recognition of unknown cultural phenomena and to the absolute dating of volcanic activity in the region. **Table 2** shows details of all samples presented in the study, including sample code,  $^{14}\text{C}$  age with 1 standard deviation, calibrated ages for  $1\sigma$  and  $2\sigma$  ranges, sample material, site, and archaeological classification of sampled context.

As for early Eneolithic in Campania, evidence from two sites has been explored. First, it is a new cultural phenomenon called "Taurasi" identified by its characteristic findings. Four  $^{14}\text{C}$  dates on charcoals from Taurasi (AV) show that the site was occupied from early second half of the 4<sup>th</sup> millennium cal BC. The tombs sampled for charcoals contained also cremated bones, which may well serve to refine the absolute dating in the future. At the same time, they enable to make a comparison of  $^{14}\text{C}$  dates measured on different material from the same site.



**Fig. 8.** Calibration and comparison of results obtained in the present work for charred seeds coming from "Forum" area - Gricignano d'Aversa (CE) and the only  $^{14}\text{C}$  age obtained in the literature, for the Agnano MS eruption.



**Fig. 9.** Calibration of the radiocarbon age of a charcoal coming from Atena Lucana (SA).

**Table 2.** All results obtained in this work from samples collected in sites belonging to the Eneolithic period are shown with own sample code,  $^{14}\text{C}$  age with 1 standard deviation, calibrated ages for 1 $\sigma$  and 2 $\sigma$  ranges, type of material, site, and archaeological classification of sampled context.

Sample Code	Locality	Archaeological period/Culture	Sample description	$^{14}\text{C}$ age $\pm 1\sigma$	Calibrated age (BC, 68.2%)	Calibrated age (BC, 95.4%)
CIRCE_DSH:280	Taurasi (AV)	Early Eneolithic/Taurasi	charcoal_Tomb 2/9 from structure 2	<b>4683<math>\pm</math>20</b>	3520-3370	3620-3370
CIRCE_DSH:279	Taurasi (AV)	Early Eneolithic/Taurasi	charcoal_Tomb 3/1 from structure 3	<b>4662<math>\pm</math>25</b>	3510-3370	3520-3360
CIRCE_DSH:281	Taurasi (AV)	Early Eneolithic/Taurasi	charcoal_Tomb 1/4 from structure 4	<b>4567<math>\pm</math>24</b>	3370-3130	3490-3110
CIRCE_DSH:278	Taurasi (AV)	Early Eneolithic/Taurasi	charcoal_Tomb 5/4 from structure 5	<b>4632<math>\pm</math>23</b>	3500-3360	3510-3350
CIRCE_DSA:578	Casalbore (AV)	Early Eneolithic	charcoal_QB6 Strato 5a	<b>4834<math>\pm</math>20</b>	3650-3540	3660-3530
CIRCE_DSA:581	Casalbore (AV)	Early Eneolithic	charcoal_QB5 Strato 4c	<b>4824<math>\pm</math>30</b>	3660-3530	3660-3520
CIRCE_DSA:576	Casalbore (AV)	Early Eneolithic	charcoal_T.86 Strato 4B Settore NE	<b>4784<math>\pm</math>20</b>	3640-3530	3640-3520
CIRCE_DSA:569	Casalbore (AV)	Early Eneolithic	charcoal_QB5/B6 Strato 4b	<b>4768<math>\pm</math>54</b>	3640-3510	3650-3370
CIRCE_DSA:568	Casalbore (AV)	Early Eneolithic	charcoal_QB5 Strato 4 Settore SE	<b>4527<math>\pm</math>28</b>	3360-3110	3360-3100
CIRCE_DSH:106	Sorrento (NA)	Middle Eneolithic /Gaudio	human bone*_ T2-D1	<b>4247<math>\pm</math>37</b>	2910-2270	2930-2690
CIRCE_DSH:102	Caivano (NA)	Middle Eneolithic	S.489/492_US67_bone*_below Agnano 3	<b>4230<math>\pm</math>20</b>	2900-2870	2910-2750
CIRCE_DSH:124	Caivano (NA)	Middle Eneolithic	S.489/492_US67_charcoal_below Agnano 3	<b>4192<math>\pm</math>23</b>	2880-2700	2890-2670
CIRCE_DSH:130	Caivano (NA)	Middle Eneolithic	S.489/492_US66_charcoal_within Paleoastroni 2	<b>4215<math>\pm</math>20</b>	2890-2760	2900-2700
CIRCE_DSH:119	Caivano (NA)	Middle Eneolithic	S.489/492_US89_bone_above Paleoastroni 2	<b>4216<math>\pm</math>22</b>	2890-2760	2900-2700
CIRCE_DSH:104	Caivano (NA)	Middle Eneolithic	S.489/492_US90_bone*_above Paleoastroni 2	<b>4248<math>\pm</math>20</b>	2895-2875	2910-2770
CIRCE_DSH:101	Sala Consilina (SA)	Middle Eneolithic	human bone_T.1076*	<b>4098<math>\pm</math>20</b>	2840-2570	2860-2570
CIRCE_DSH:100	Sala Consilina (SA)	Middle Eneolithic	human bone_T.1077*	<b>4175<math>\pm</math>24</b>	2880-2690	2890-2660
CIRCE_DSH:118	Sala Consilina (SA)	Middle Eneolithic	human bone_T.1073	<b>4128<math>\pm</math>20</b>	2860-2630	2870-2580
CIRCE_DSH:117	Sala Consilina (SA)	Middle Eneolithic	human bone_T.1074	<b>4140<math>\pm</math>20</b>	2860-2630	2880-2620
CIRCE_DSH:547	Mirabella Eclano (AV)	Middle Eneolithic /Gaudio	human bone_Capo Tribù	<b>4104<math>\pm</math>48</b>	2860-2570	2880-2490
CIRCE_DSH:588	Mirabella Eclano (AV)	Middle Eneolithic /Gaudio	dog_Capo Tribù	<b>4102<math>\pm</math>30</b>	2850-2750	2870-2500
CIRCE_DSH:125	Gricignano d'Aversa (CE)	Late Eneolithic/Laterza	US2315-2254_charred seed_paleosurface on the top of Agnano MS and sealed by Phlaegrea 1	<b>4010<math>\pm</math>20</b>	2570-2485	2575-2470
CIRCE_DSH:126	Gricignano d'Aversa (CE)	Late Eneolithic/Laterza	US2315_charred seed_paleosurface on the top of Agnano MS and sealed by Phlaegrea 1	<b>4000<math>\pm</math>20</b>	2565-2475	2580-2470
CIRCE_DSH:123	Atena Lucana (SA)	Late Eneolithic/Cetina	charcoal_US 300 ampl. Sud 22-IV-06	<b>3868<math>\pm</math>75</b>	2470-2210	2600-2050

\* Bone chemically treated at the Oxford laboratory.

Second, five new  $^{14}\text{C}$  dates on samples from Santa Maria dei Bossi (Casalbore, AV) place the Eneolithic phase of this site just before the time of Taurasi. However, according to recent investigations of archaeological evidence, both sites seem to represent the same and by now unknown cultural phenomenon.

Accordingly, Taurasi and S. Maria dei Bossi represent a sizeable part of 4<sup>th</sup> millennium cal BC. It is of interest that similar pottery and cremations have been recently found in the first phase of Sala Consilina. Results from this site that is still under investigation are awaited to

enumerate chronological evidence for the Early Eneolithic in Campania.

Next, Campanian Middle Eneolithic evidence has been investigated. We have studied Piano di Sorrento and Mirabella Eclano, two sites of Gaudio culture, and two further sites, which by now remain culturally closely undetermined – Sala Consilina II and Caivano. Twelve  $^{14}\text{C}$  dates have shown that these four sites date from the first half of 3<sup>rd</sup> millennium cal BC. Such result implies that the Middle Eneolithic in Campania was a period, when several cultures coexisted or in short intervals fol-

lowed one after another. As outlook, it is new Campanian sites, presently under excavations, what in the future may give important insights into the chronology of Gaudio culture.

Our study has made also a contribution to absolute dating of volcanic eruptions by means of samples from Caivano, located below Agnano 3 and above Paleoastroni 2 deposits. The new data represent a chronostratigraphic marker for cultural and paleoenvironmental reconstructions and may well be useful for future research.

The Late Eneolithic in Campania characterize three  $^{14}\text{C}$  dates from Gricignano d'Aversa and Atena Lucana (2570-2210 BC, 68.2% probability; 2575-2050 cal BC, 95.4% probability). Moreover, Gricignano d'Aversa gives new indications about chronology of Agnano-Monte Spina and Phlegrea 1 eruptions.

Another important result concerns the distinction between two cultural phases during the second half of the 3<sup>rd</sup> millennium cal BC, namely Laterza, well known in Campania, and Çetina, identified in this region for the first time. Further investigations and analyses on bones coming from Gricignano d'Aversa and Torre le Nocelle (AV) will allow us to seek the start of Laterza culture deeper in the past.

Ultimately, the new measurements of CIRCE AMS laboratory in Caserta enabled to construct the absolute chronology of Eneolithic in Campania from its beginnings in the early second half of the 4<sup>th</sup> millennium until its end in the late 3<sup>rd</sup> millennium cal BC. The fresh absolute-chronological evidence has shed new light on cultural development of Campanian Eneolithic and has shown that the beginning of the period that was thought to have been well established has to be re-evaluated.

Last but not least, the work has produced new evidence relevant for the regional volcanic chronostratigraphy and for understanding the relationship between human habitation and volcanic activity in the region.

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