

## LATE WÜRMIAN TO EARLY HOLOCENE LAKE DEPOSITS AND PYROCLASTICS IN THE MIDDLE VOLTURNO BASIN (CASERTA PROVINCE, ITALY)

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**ABSTRACT** - *Late Würmian to early Holocene lake deposits and pyroclastics in the middle Volturno basin (Caserta Province, Italy)* - *Il Quaternario* 2, n. 2, 1989, p. 119-123 - During a soil survey of the Middle Volturno basin hitherto unknown lacustrine deposits were encountered. The former lacustrine plain, although fluvially dissected and partly covered by colluvial and fluvial deposits and by volcanic tuffs, is still easily recognized. The lacustrine deposits are highly tuffaceous and have common tuff intercalations, but rest on and thus postdate the "Tufo grigio campano". Considering the tephrochronology of the Late Quaternary in this part of Italy they must be contemporaneous with the "second Phlaegrean Period" (Lateglacial). Charcoal, found in the lacustrine deposits in association with skeletal remains of *Bos primigenius*, indeed appeared to date from 12500 ± 100 Years BP. Additional evidence for a large scale deposition of volcanic ash during that period comes from the Matese and from the Agro Pontino. The observations show that volcanic ashes, erupted during the second Phlaegrean Period, have a much wider distribution than earlier assumed.

**RIASSUNTO** - *Piroclastiti e depositi lacustri dal tardo Würm all'Olocene inferiore nel bacino del medio Volturno (Provincia di Caserta, Italia)*. *Il Quaternario* 2, n. 2, 1989, p. 119-123 - Nel corso di un rilevamento pedologico nel medio bacino del Volturno, sono stati scoperti dei depositi lacustri prima sconosciuti. L'antica piana lacustre, malgrado sia ora incisa e in parte ricoperta da sedimenti colluviali e fluviali, è tuttavia facilmente riconoscibile. I depositi lacustri hanno forte componente tuffacea e contengono numerose intercalazioni piroclastiche; ricoprono il Tufo Campano, di cui sono evidentemente posteriori. Sulla base della tefrocronologia di questa parte d'Italia essi dovrebbero risalire al "Secondo periodo flegreo" (Tardiglaciale). I carboni raccolti nei depositi lacustri, associati a resti di *Bos primigenius*, datano infatti a 12.500 ± 100 anni fa.

Altri dati circa importanti depositi di cenere vulcanica di questo periodo provengono dall'Agro Pontino e dal Matese. L'estensione delle ceneri vulcaniche risalenti al secondo periodo flegreo hanno una diffusione molto maggiore di quanto finora ritenuto.

**Key-words:** Tephrochronology, C<sup>14</sup> dating, fauna (diatoms, pollen, *Bos primigenius*)

**Parole chiave:** Tefrocronologia, datazione con C<sup>14</sup>, fauna (diatomee, pollini, *Bos primigenius*)

### 1. INTRODUCTION

In the course of a soil survey, carried out by the second author, extensive lake deposits and associated pyroclastics of Late Würmian age were discovered in the Middle Volturno basin. The lacustrine sediments post-date the "ignimbrite campana" ("Tufo grigio campano") and contain frequent intercalations of more recent tuffs. These tuffs were also found to abound in the adjacent mountainous areas.

Until yet very little attention has been paid to these lacustrine deposits as well as to the younger (Late Würmian to Holocene) tuffs in the middle Volturno basin. In this paper the general characteristics, distribution and stratigraphy of these various sediments as well as the results of radiocarbon, pollen and diatom analyses will be described and discussed. Furthermore, attention is also paid to skeletal remnants of *Bos primigenius*, found in the lake deposits.

### 2. FIELD OBSERVATIONS AND ANALYSES

The areal distribution of the tuffaceous, clayey to loamy lacustrine deposits is indicated in Fig. 1; over relatively large areas they are covered by more recent deposits of various origin.

From borings and exposures it could be established that in the northern part of the area the lake deposits reach a thickness of about 4 metres, whereas to the south they are generally thinner (only a few metres). The sediments consist of grey coloured tuffaceous clays and silts which are horizontally bedded (locally laminated) and have intercalations of nonstratified mostly fine-grained and highly vitreous tuffs (generally less than 1 m thick). In the northern border zone variegated (greyish, blueish and reddish) calcareous clays predominate, which presumably are of local fluvial origin.

The lacustrine plain is still easily recognised,

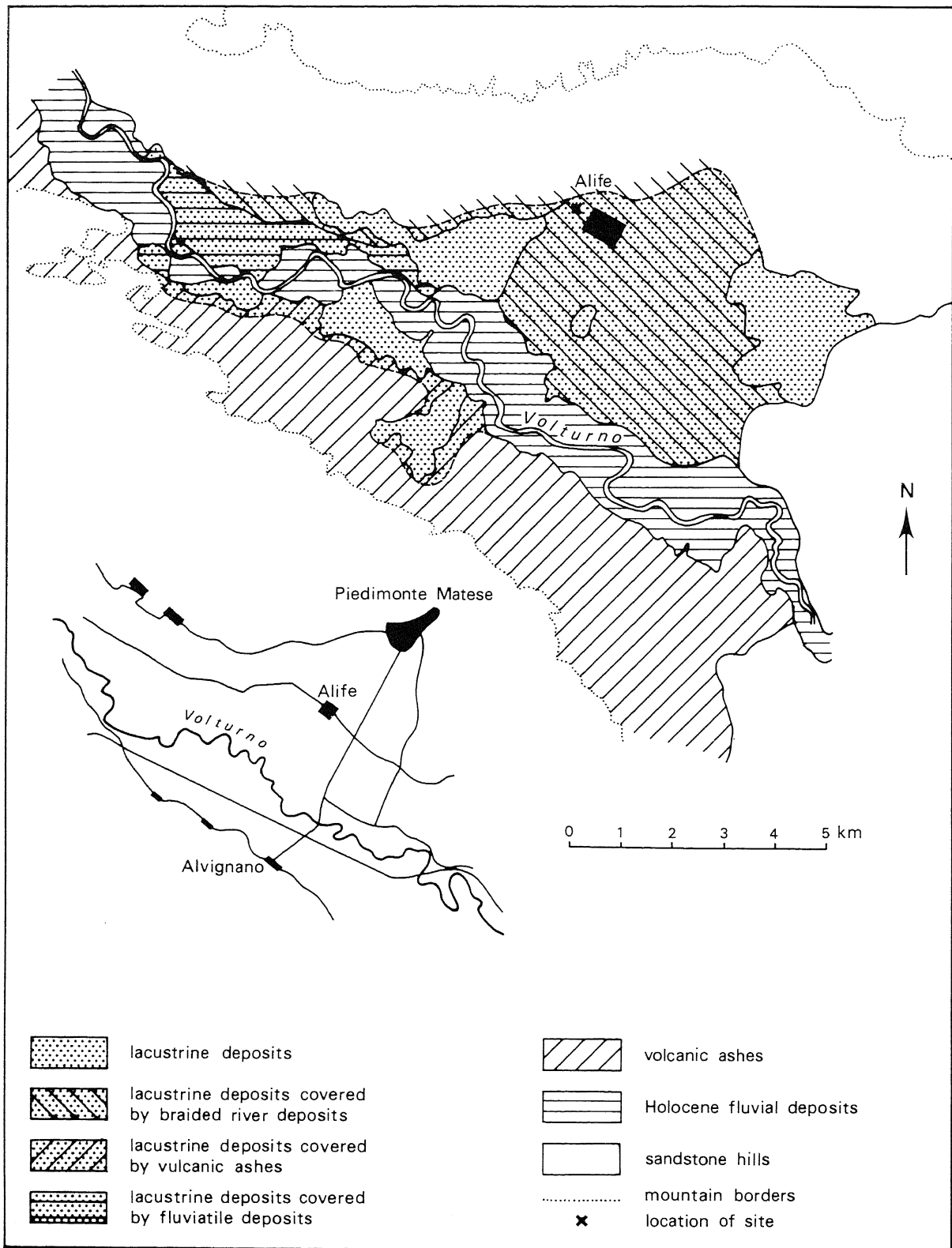


Fig. 1 - The distribution of various Late Quaternary deposits in the Middle Volturno basin  
*Distribuzione dei depositi quaternari nel medio bacino del Volturno*

although it is dissected by the river Volturno (presently about 7 m below the surface of the plain) and is partly covered by later deposits. These later deposits include highly tuffaceous colluvial deposits and fluvial deposits and, in the southern border zone, tuffs. Their distribution is indicated in Fig. 1.

The lacustrine deposits and later fluvial and colluvial deposits rest on ignimbrite ("Tufo grigio campano"), which only rarely is exposed and of which the thickness is unknown as its base is not exposed. In the narrow passage of the Volturno river through the sandstone hills near Alvignano and to the east of this passage, the ignimbrite reaches a thickness of more than 15 metres and an altitude of about 110 m a.s.l. This altitude corresponds with the highest altitudes at which lacustrine deposits have been observed. The ignimbrite shows all features, characteristic for the upper member of the "Tufo grigio campano": it is grey coloured, highly vitreous, low in phenocrysts and has pumiceous inclusions.

Study of samples from several sites showed that in the lacustrine deposits pollen is only present in very small quantities and therefore cannot be used to date the deposits. Diatom analysis showed rather surprisingly that about 70-80% of the diatoms encountered are indicative of a marine to brackish depositional environment. Considering the altitude (approx. 100 m a.s.l.), geographical position (about 60 km from the Tyrrhenian Sea) and age (Late Würmian to Early Holocene, see discussion) of the lacustrine sediments such a marine origin must be excluded. It is therefore concluded that the diatoms are inherited from older (Miocene and earlier) marine sediments present within the drainage basin.

During the construction of a drainage canal near Alife large sections of the lacustrine deposits and underlying ignimbrite were exposed. In one of these exposures (see Fig. 1) at 2 metres depth, on top of an ignimbrite and covered by tuffaceous lacustrine deposits (about 130 cm thick), a thin (a few cm) and discontinuous, probably fluvial, gravel bed was found which contained skeletal remnants and charcoal. The underlying ignimbrite most probably represents the "Tufo grigio campano", but could not be identified as such with certainty. The exact location of the site is on the eastern wall of the canal, approx. 25 m S of the road, no. 158 Alife - Sant'Angelo d'Alife, 475 m NW from the Porta di Roma at Alife (41°19'53"N; 1°52'15"E, sheet 172, topographical map of Italy).

The skeletal remains have been identified as *Bos primigenius* (aurochs) and consist of: 2 skull fragments with horncores; 3 cervical vertebrae; 4 molars and 3 premolars; 1 os carpale 2 + 3, dex.; 1 metacarpal, dex.; 2 phalanx 1, dex. The basal circumference of the horncores (330 and 340 mm) points to a male specimen (Grigson, 1978). The carpal, metacarpal and phalanges without doubt belong to one and the same individual. As

these remains have been found within a distance of about 2 m from the skull fragments and teeth, all probably belong to one individual.

Bones of aurochs have been reported from numerous Middle and Late Paleolithic sites from Italy (Barker, 1981a and 1981b). The associated charcoal has been dated by C<sup>14</sup> as 12.500 ± 100 BP by the Paleoecology Laboratory of the Queens University of Belfast (Northern Ireland), which implies a Lateglacial age.

As stated in the introduction, in the adjacent mountains (Monte Maggiore, Matese) tuffs are rather common. They frequently have intercalated paleosols and can be subdivided into rather recent tuffs, which are at most a few metres but generally less than 1 m thick, with relatively weakly developed soils (Andosols), and into older tuffs with more evolved soils (mostly Luvisols). Similar observations were made in the Upper Volturno basin (van Otterloo, 1982).

Table 1 - Pollenanalytical data of 3 samples from the basal part of a younger tuff near the Lago del Matese  
*Dati pollinici di tre campioni della parte basale di un tufo recente presso il Lago del Matese*

	Top	Middle part	Base
Arboreal pollen			
<i>Alnus</i>	3	3	2
<i>Betula</i>		+	
<i>Pinus</i>	7	8	8
<i>Salix</i>	+	+	
Non-Arboreal pollen			
<i>Compositae</i>	41	42	44
<i>Cruciferae</i>	+		+
<i>Gramineae</i>	48	44	42
<i>Rosaceae</i>	+		+
<i>Rumex</i>	3	2	2
<i>Polypodiaceae</i>	17	22	24

The results of the pollen analysis of a section through such tuffs from the border zone of the Lago del Matese are presented in Table 1. They concern the pollen in the lower centimetres of a younger tuff in which a distinct Andosol has developed, and which covers a paleosol in older tuff. The pollen data thus provide information on the vegetation at the onset of the latest volcanic phase and show a predominance of *Gramineae* and *Compositae*.

### 3. DISCUSSION

Within the studied area a clear distinction can be made between the ignimbrite and the younger tuffs, which are contemporaneous with the subsequent lacus-

trine phase.

The explosive eruptions which generated the "Tufo grigio campano" are generally assumed to date from about 30.000 Y BP (The first Phlaegrean Period, Di Girolamo et al., 1972). This ignimbrite covered large parts of Campania, including the Middle Volturno basin. According to the literature (Di Girolamo et al., 1972; Rosi and Sbrana, 1987) the next major eruptive phase, of relevance for the area studied, is the second Phlaegrean Period, dating from the Lateglacial and during which the "Tufo giallo napoletano" was formed.

The lacustrine deposits covering the  $C^{14}$  dated fluvial bed near Alife are rather thin (130 cm) and are situated close to the border of the ancient lake. In the central part of the Middle Volturno basin the onset of the lacustrine phase might therefore date from earlier than 12.500 Y BP, although a much earlier age seems unlikely for the following reasons:

In the section near the Lago del Matese, the presence of a well developed paleosol in the underlying tuff implies that the younger tuff was deposited subsequent on a fairly long intermediate period without significant ash deposition. The correlation of these two tuffs with respectively the intercalated tuffs and the "Tufo grigio campano" is obvious. The scarce pollen data cannot be used to precisely date the younger tuff. However, the spectra are quite characteristic for the transitional periods (cold to warmer) during the Lateglacial and Early Holocene (Frank, 1969). More to the north, in the Venafrò area and adjacent parts of Lazio, Arnoldus-Huyzendveld et al. (1985) observed similar phenomena, i.e. two tuffs of which the upper dates from the Lateglacial ( $C^{14}$  dated) and which are separated by a well developed paleosol.

Indications that during the intermediate periods ash deposition was minimal in the area NW of the Campanian eruption centres were also found during investigations on Holocene and Late Würmian deposits in the Agro Pontino (about 80 km to the NW). In a  $C^{14}$  dated sediment core two tuff layers of Lateglacial age were found, covered by and resting on peats and clays, free of any volcanic material (Eisner et al., 1986). The total thickness of these two layers, respectively of about the same age as and of slightly younger age than the  $C^{14}$  dated bed near Alife, is in the order of 10 cm.

Considering the foregoing observations, which are in line with the existing tephrochronological record, it must be assumed that a distinct hiatus exists between the deposition of the "Tufo grigio campano" and the onset of the lacustrine sedimentation, the latter possibly dating from the earlier part of the Lateglacial. Furthermore, it can also be assumed that the homogeneous and fine-grained younger tuffs represent the northwestern extension of the "Tufo giallo napoletano".

The reasons why the lake came into being are not clear. As described before, the ignimbrite partially filled

the valley of the Volturno near Alvignano and thus may have obstructed the drainage of the valley. From paleo-ecological studies it is well known (see for example Wymstra, 1969, and Eisner et al., 1986) that at the end of the Würm glacial period climate changed from arid towards more humid. Therefore, given the potentially poor drainage of the valley, a climatic origin of the lake cannot be excluded. However, the lake also may have been formed through blocking of the drainage by the pyroclastics of the second Phlaegrean Period.

The younger tuffs form intercalations within the lacustrine sediments and, in the southern border zone of the basin, cover these sediments. On the later fluvial terraces, however, they are completely lacking. From this distribution pattern it can be concluded that during a late phase the dimensions of the lake had been considerably reduced and that the ash deposition stopped before the termination of the lacustrine phase. In view of the extensive development of a series of fluvial terraces by the Volturno and of the moderate degree of soil formation in these terraces, the upper limit of the period of ash deposition and lacustrine sedimentation cannot be estimated as much later than Early Holocene.

#### 4. CONCLUSIONS

During the first Phlaegrean Period the whole of the Middle Volturno basin has been covered by ignimbrite ("Tufo grigio campano"), which blocked the narrow passage of the Volturno near Alvignano. This volcanic phase was followed by a period without or with only minor ash deposition. Subsequently, towards the end of the Pleniglacial or early during the Lateglacial an extensive lake was formed in the Middle Volturno basin. This lake most probably lasted till the Early Holocene, after which the fluvial system was restored, but in a late phase had a more reduced size. The lake reached an altitude of about 110 m a.s.l. and had a depth of at most a few metres.

During the lacustrine phase volcanic ashes, which are considered to represent the northwestern extension of the "Tufo giallo napoletano" were deposited throughout the area. In the lacustrine deposits they are found as admixtures (tuffaceous clays and loams) and as intercalated tuff layers, illustrating the complex nature of this volcanic phase. Thusfar, the rather massive occurrence in the middle Volturno basin of ashes related to the "Tufo giallo napoletano" seems to have remained unnoticed. It is, however, in line with the observations of Arnoldus-Huyzendveld et al. (1985), which showed that such ashes are also rather widespread in southern Lazio.

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