

Annually Laminated Sediments at Valle di Castiglione (Rome, Italy)

Abstract

In the lacustrine record of Valle di Castiglione, near Rome, the silty sediments deposited during the forest period Roma I, corresponding to the oldest peak in stage 7 of the oxygen isotopic record, are formed by fine alternating dark and pale laminae.

Palynological and chemical investigations have enabled the annuality of each couplet to be recognized, and the mechanism and the environment of the sediment deposition, related to alternating wet and dry seasons, to be determined.

The sediment changes observed at an annual timescale fit in well with the lithostratigraphic and palynological data of the whole sequence, at a plurimillennial timescale.

Riassunto

Nella sequenza lacustre di Valle di Castiglione, presso Roma, i sedimenti relativi alla fase forestale Roma I, che corrisponde al picco più antico dello stadio 7 degli isotopi dell'ossigeno, sono costituiti dall'alternanza di sottili lamine chiare e scure.

Le analisi palinologiche e chimiche hanno consentito di riconoscere l'annualità di ogni singola coppia, e di ipotizzare il meccanismo e l'ambiente di deposizione, determinato dall'alternanza di stagioni umide e aride.

I cambiamenti riconosciuti nel sedimento ad una scala annuale concordano ampiamente con i dati litostratigrafici e palinologici dell'intera sequenza a scala plurimillennaria.

Introduction

Annually laminated sediments are frequently found in lacustrine sequences from temperate zones, where they are extensively used in palaeoecological studies. The applications are numerous as they can provide a

precise chronological background for all stratigraphical data, and give information on the history of vegetation and in general about climatic variations. When they are found at the topmost part of a Holocene sequence they represent a useful tool for determining the extent of human influence on the landscape.

In the present paper, annually laminated sediments from a lengthy sequence near Rome have made it possible to highlight the environmental characteristics of the interglacial period preceding the Eemian (Roma I), which is still poorly known.

Valle di Castiglione is a dried out maar-lake belonging to the Colli Albani volcanic complex. It is situated about 20 km east of Rome (latitude 42°N altitude 44 m a.s.l.). The catchment area is entirely composed of pyroclastic rocks. The lake bed is circular in shape, its diameter being about 1 km.

The lacustrine sediments of the Valle di Castiglione sequence, drilled by a 88 m deep continuous borehole, have formed the subject of multidisciplinary studies involving lithostratigraphic and palynological investigations (Follieri, Magri and Sadori, 1988, 1989; Follieri, Magri and Narcisi, 1990; Narcisi *et al.*, 1992). ¹⁴C datings (Alessio *et al.*, 1986), comparison with oxygen isotope curves, synchronization with the precessional motion of the Earth (Magri, 1989) and biostratigraphical characters of the past vegetation (Follieri, Magri and Sadori, 1989) have provided the chronological framework of the whole sequence, which records over 250,000 years of environmental history, without significant interruptions.

The lithostratigraphic sequence can be schematized as two alternating lithotypes at a plurimillennial timescale. The first lithotype is characterized by heavy minerals, leucite, feldspars, aeolian quartz and organic matter. It is interpreted as being of detrital origin with sedimentation after active erosion and transportation processes, in wet climatic conditions.

The other lithotype is characterized by the presence of calcium carbonate and by low contents of organic matter, aeolian quartz and detrital minerals. It is interpreted as being predominantly of chemical origin. The precipitation of carbonates took place during arid periods with reduced water inflow to the lake, when the underground inflows, rich in bicarbonate, were more abundant than the surface ones.

The pollen record, showing two complete interglacial-glacial cycles, can be schematized as alternating forest and steppe phases at a plurimillennial timescale, the former are interpreted as periods of great wetness, the latter as periods which were, by and large, arid.

The forest phases mostly differ from each other both in the dominant vegetal configurations and in the presence of taxa nowadays extinct in Italy.

They are climatically distinct and are significant from the biostratigraphic point of view.

The steppe phases mostly contain the same flora, with *Artemisia*, Gramineae and Chenopodiaceae, and are not significantly differentiated from the climatic point of view.

Both the lithotype and pollen zone sequences, as well as the respective palaeoenvironmental interpretations, show significant concordances: the deposition of clastic sediments occurred during forest phases, in wet climatic

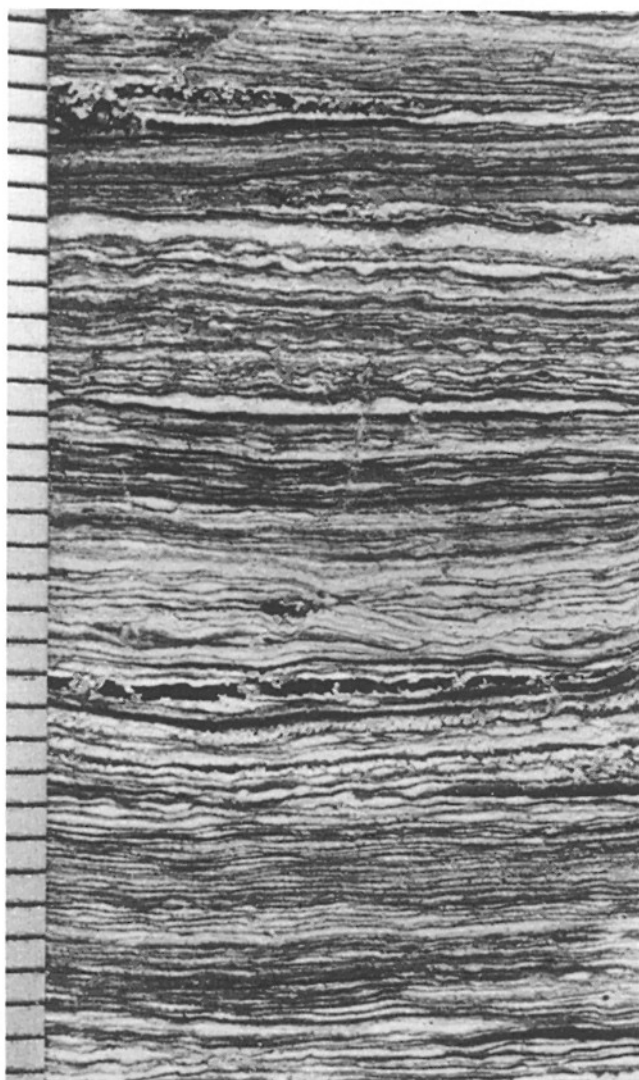
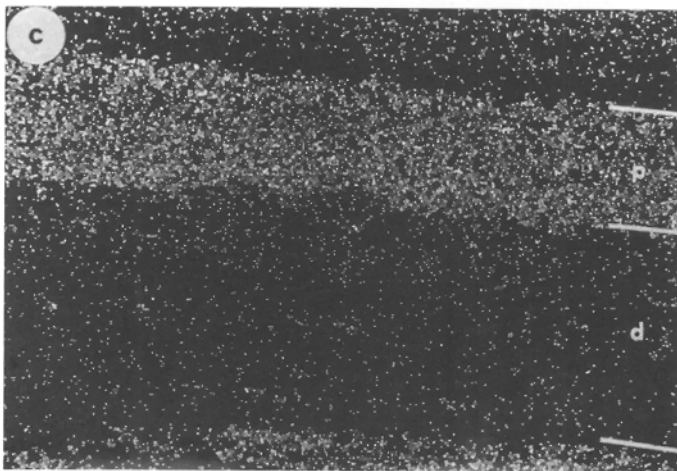
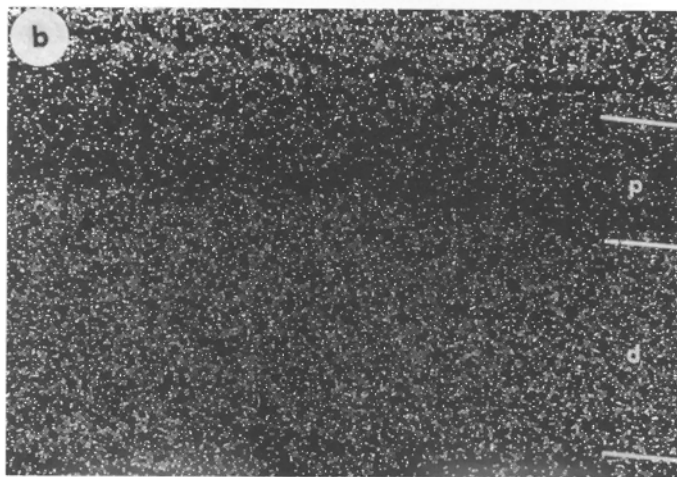
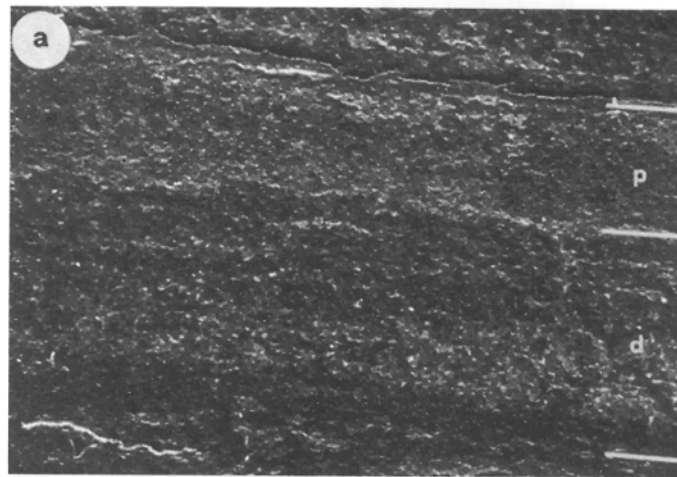


Fig. 1. Laminated sediments at 70.80 m from the Valle di Castiglione core. The scale divisions on the left are 1 mm.



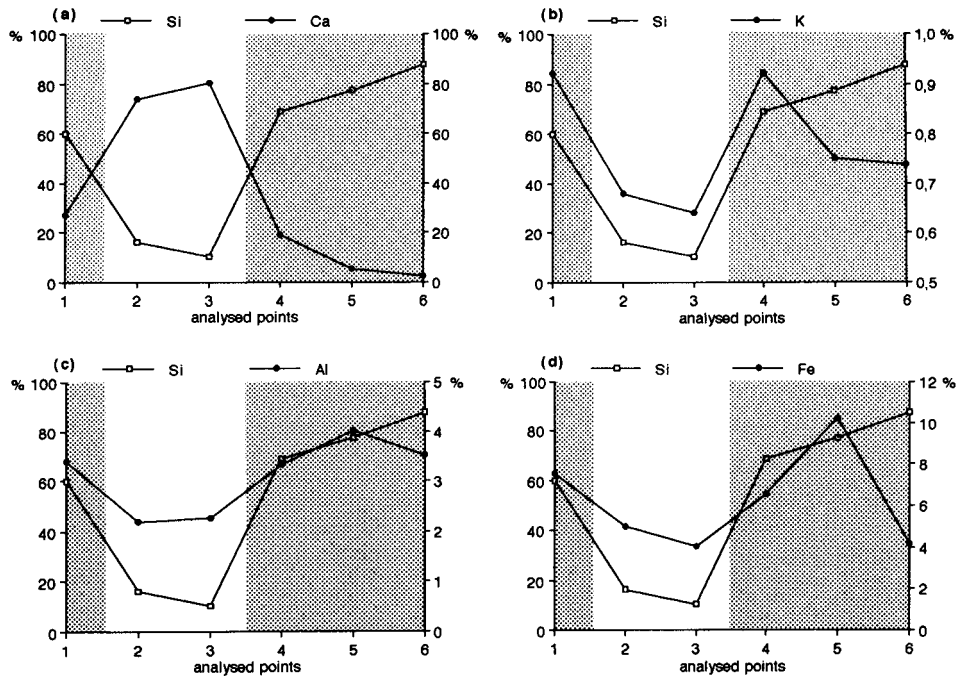


Fig. 3. Distribution of Si and a) Ca, b) K, c) Al and d) Fe along a transect of the sample in fig. 2 (72.45 m); the step intervals between the points analysed are arbitrary. The shaded areas correspond to the dark laminae.

conditions, while the deposition of calcareous sediments occurred during steppe periods, in substantially arid conditions (Follieri, Magri and Narcisi, 1990).

Analysis of the laminated sediments

Laminated sediments formed by pairs of dark and pale laminae are found only in the deeper part of the sequence: intervals of limited thickness are present between 63.50 and 60.00 m in the period corresponding to the forest phase Roma II (ca. 190,000 years BP); a relatively continuous interval between 72.50 and 69.50 m in the sediments corresponding to the forest phase Roma I (ca. 210,000 years BP) forms the subject of the geochemical and palynological investigations reported here.

Almost 2000 couplets have been counted between 71.40 and 70.80 m. In Fig. 1 a sample from 71.00 m is shown.

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Fig. 2. a) SEM image of a laminae couplet at 72.45 m from Valle di Castiglione within an area 0.6×0.4 mm; b) distribution of Silicon within the same area as Fig. 2a; c) distribution of Calcium within the same area as Fig. 2a; p: pale lamina, d: dark lamina.

The chemical composition has been determined using a scanning electron microscope (SEM) equipped with an energy dispersive spectrometer (EDS). Measurements of all major elements were performed from polished thin sections of dried sediment immersed in EPOFIX impregnating medium under a vacuum, using the same techniques as in Peglar *et al.* (1984). In Fig. 2a a SEM image of a couplet at 72.45 m is shown; Fig. 2b and Fig. 2c represent the distribution of Silicon and Calcium within the area of Fig. 2a. It is evident that Si is more abundant in the dark lamina, while Ca is more abundant in the pale one. The distribution of these two elements is represented in Fig. 3a; their antithetic behaviour is evident. K, Al and Fe

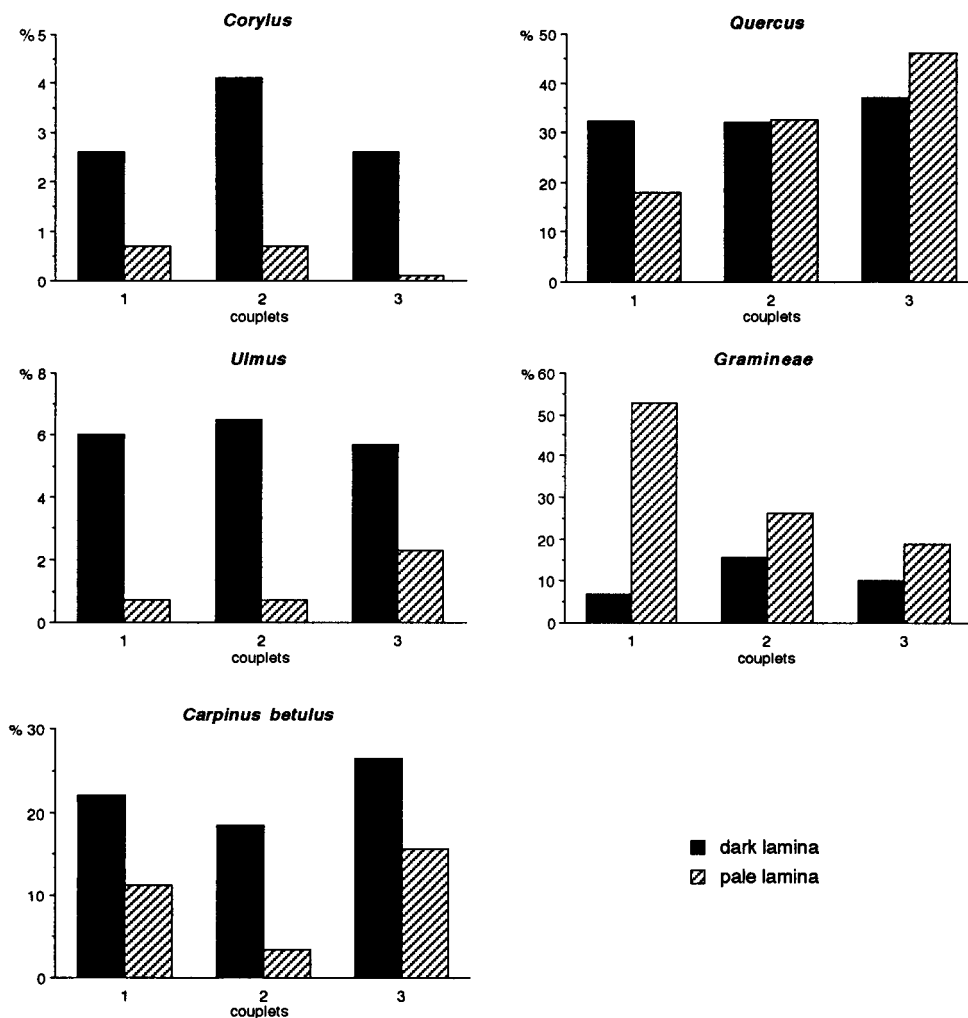


Fig. 4. Pollen analysis of three couplets at 70.80 m from Valle di Castiglione.

display the same trend as Si (Figs. 3b, 3c, 3d). As these elements are the major constituents of the volcanic rocks composing the catchment area of the lake, the chemical results indicate that the dark laminae are mostly made up of clastic matter. On the contrary the abundance of Ca in the light laminae (Fig. 3a), in correspondence with a strong reduction of clastic supply, indicates that the pale laminae represent the accumulation of chemically deposited calcium carbonate.

The results of pollen analysis of three couplets of laminae from a sample at 70.80 m are illustrated in Fig. 4, in which pollen percentages of *Corylus*, *Ulmus*, *Carpinus betulus*, *Quercus* spp. and Gramineae are represented. The dark laminae were deposited in winter and early spring, as they contain pollen of plants flowering at present in Central Italy from January to April (*Corylus*, *Ulmus*, *Carpinus*). The light laminae were deposited in summer, as they contain abundant pollen of grasses whose flowering season is mostly in summer, from May to August. *Quercus*, which usually blooms in Italy from April to June, is equally distributed both in the dark and in the pale laminae.

Conclusions

The comparative analysis of the results indicates the seasonality of the laminae: each couplet, composed of a dark layer and a pale one, represents the sedimentation for one year. The average accumulation rate obtained from the counting is around 0.31 mm/yr. This value agrees well with the accumulation rate values obtained by the methods mentioned above which were used to set the sequence in a chronological framework.

The presence of annually laminated sediments during the forest phase Roma I, which may be correlated with the oldest peak (7.5) in stage 7 of the oxygen isotopic record (Pisias *et al.*, 1984), indicates marked seasonal differences in climate; in particular, during wintertime (the dark laminae, according to the palynology) significant rainfall occurred which determined the transportation of the clastic supply to the lake; in summertime (the light laminae, according to the palynology) arid conditions occurred, favouring the chemical deposition of calcium carbonate.

It is worth pointing out that the alternating wet and dry seasons recorded by the laminated sediments at an annual timescale strongly resemble the alternating wet and dry periods evidenced at Valle di Castiglione for the whole sequence at a timescale of thousands of years.

In this respect, the data presented here, even if not particularly detailed, take on a special value in that they are in agreement with wider palaeoclimatic and palaeoenvironmental interpretations.

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Donatella MAGRI

Dipart. Biologia Vegetale
Università « La Sapienza »
P.le Aldo Moro 5
I - 00185 ROMA
Italia

Biancamaria NARCISI

ENEA C.R.E. Casaccia
C.P. 2400
I - ROMA
Italia

REFERENCES

- ALESSIO, M., ALLEGRI, L., BELLA, F., CALDERONI, G., CORTESI, C., DAI PRA, G., DE RITA, D., ESU, D., FOLLIERI, M., IMPROTA, S., MAGRI, D., NARCISI, B., PETRONE, V. and SADORI, L., 1986, ¹⁴C Dating, Geochemical Features, Faunistic and Pollen Analyses of the Uppermost 10 m Core from Valle di Castiglione (Rome, Italy), in *Geologica Romana*, 25, p. 287-308 (publ. 1989).
- FOLLIERI, M., MAGRI, D. and NARCISI, B., 1990, *A Comparison between Lithostratigraphy and Palynology from the Lacustrine Sediments of Valle di Castiglione (Roma) over the Last 0.25 MA*, in *Mem. Soc. Geol. It.*, 40, p. 889-891.
- FOLLIERI, M., MAGRI, D. and SADORI, L., 1988, *250,000 Year Pollen Record from Valle di Castiglione (Roma)*, in *Pollen et Spores*, 30, p. 329-356.
- FOLLIERI, M., MAGRI, D. and SADORI, L., 1989, *Pollen Stratigraphical Synthesis from Valle di Castiglione (Roma)*, in *Quaternary International*, 3/4, p. 81-84.
- MAGRI, D., 1989, *Interpreting Long-Term Exponential Growth of Plant Populations in a 250,000 Year Pollen Record from Valle di Castiglione (Roma)*, in *New Phytologist*, 112, p. 123-128.
- NARCISI, B., ANSELMINI, B., CATALANO, F., DAI PRA, G. and MAGRI, G., 1992, *Lithostratigraphy of the 250,000 Year Record of Lacustrine Sediments from the Valle di Castiglione Crater, Roma*, in *Quaternary Science Reviews*, 11, p. 353-362.
- PEGLAR, S.M., FRITZ, S.C., ALAPIETI, T., SAARNISTO, M. and BIRKS, H.J.B., 1984, *Composition and Formation of Laminated Sediments in Diss Mere, Norfolk, England*, in *Boreas*, 13, p. 13-28.
- PISIAS, N.G., MARTINSON, D.G., MOORE, T.C. Jr., SHACKLETON, N.J., PRELL, W., HAYS, J. and BODEN, G., 1984, *High Resolution Stratigraphic Correlation of Benthic Oxygen Isotopic Records Spanning the Last 300,000 Years*, in *Marine Geology*, 56, p. 119-136.

