

CLIMEX MAPS ITALY

project sponsored by Enea and directed by C. Margottini & G.B. Vai

**LITHO-PALAEOENVIRONMENTAL MAPS OF ITALY DURING THE LAST TWO  
CLIMATIC EXTREMES**

**Map 1 - LAST GLACIAL MAXIMUM ( $22 \pm 2$  ka cal BP) average air temperature  
of about  $4.5^{\circ}\text{C}$  lower than today**

**Map 2 - HOLOCENE CLIMATIC OPTIMUM ( $8 \pm 1$  ka cal BP) average surface air  
temperature of about  $2^{\circ}\text{C}$  higher than today  
1:1,000,000 scale**

**EXPLANATORY NOTES**

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# The timberline and treeline ecocline altitude during the Holocene Climatic Optimum in the Italian Alps and the Apennines

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For the aim of the Litho-palaeoenvironmental map of Italy during the Holocene Climatic Optimum (HCO), we traced the estimated altitude of the uppermost boundary of the closed forest (timberline). Additionally, it is helpful considering here the altitude of the treeline ecotone, i.e. the climatically sensitive transitional zone between timberline and alpine communities (Tinner & Theurillat, 2003). In the alpine belt, phanerophytes are uncommon and grow only if sheltered by favourable microhabitats.

## Ecological and climatic factors affecting the treeline and timberline altitudes

Timberline and treeline ecotone altitudes depend on the ecology of the tree species forming them. *Pinus cembra*, the tree species presently reaching the maximum altitudes in the Alps (i.e. 2,550-2,600 m), is best adapted to continental climates (Tranquillini, 1976). Persistent snow cover, reduced heat flux during the growing season, and reduced growth of *Pinus cembra* explain a negative correlation between climate oceanicity and timberline altitude, or glacier ELA (Ellenberg, 1986; Orbelli et al., this issue, tab. 1). This may be observed in the modern tree geography of the Italian Alps, as treeline altitude declines from 2,450 m a.s.l. in the inner Alps to 2,050-2,100 m a.s.l. in the outermost districts of the Alps. Here, *P. cembra* does not form the timberline. A similar pattern of geographical differences can be envisaged during the HCO. This was taken into account in the estimation of HCO timberline altitude.

In the northern and central Apennines, the absence of all conifers belonging to the oroboreal belt (*Picea abies*, *Larix decidua*, *P. cembra*), together with the effects of an high oceanicity, furtherly depress the treeline to

1,900 m a.s.l. Treeline and timberline are formed by *Fagus sylvatica*. Although *Abies alba* does not take part to the present treeline ecotone, this species may have played an important role during the HCO. In the southern Apennine, there are two endemic pines linked to the Mediterranean orobiomes: *Pinus nigra* var. *calabrica* (= *P. laricio* Poirét) and *P. leucodermis*. On the Mt. Pollino massif (the maximum elevation in the Calabrian ranges), *P. leucodermis* forms the timberline at 2,000 m and the treeline at 2,100 m. On Mt. Etna volcano, *Pinus nigra* var. *calabrica* and *Betula aetnensis* form the treeline at 1,900-2,000 m altitude.

## The timberline altitude at 8 ka BP

Information on past altitude of timberline and treeline ecotone in the Alps and Apennines derives mostly from the palaeobotanical content of peat and lacustrine successions set at different altitude in the subalpine and alpine vegetation belts. These studies suggest that, between 11,000 and 4,500 a cal BP, the treeline fluctuated within a belt of 100-150 m above today's tree limit. At 4,500 a cal BP, a strong timberline depression occurred in the Alps, because of climatic deterioration and human disturbance (Aceti et al., 2004; Speranza et al., 1996; Tinner & Theurillat, 2003; Wick & Tinner, 1997).

Ongoing work in the peat bog successions in the Ortles-Cevedale massif suggests that timberline reached its maximum altitude here at around 7.4 ka cal BP (Aceti et al., 2004). At that time, the forest limit of *Pinus cembra* was lying between 2,400 and 2,550 m (Fig. 1), 100 to 150 m above the present potential timberline. Peat deposition occurred at 2,560 m a.s.l., well above the maximum altitude of late Holocene peat bogs. These data also fit the glaciological evidences, supporting an

extreme reduction of Italian and Swiss glaciers between 7.4 and 8.3 ka cal BP (Orombelli, 1998; Hormes et al., 2001), within a general phase of glacier contraction which lasted between 10 and 6 ka (Orombelli et al., this issue).

The estimated timberline altitude during HCO in the Italian Alps was derived by adding 150 m to the present potential timberline. In the Apennines, an average altitude of 2,000 m was adopted, but local wind-caused depressions to 1,800 m were represented along sharp ridges.

On the Etna volcano, the HCO tree line was formed by *Pinus nigra* var. *calabrica*, as shown by the radiocarbon datings of identified charred fragments (Cortesi et al., 1988). However, due to the intense and persistent volcanic activity throughout the Holocene, the area above 1,800 m altitude remained mostly unforested.



**Fig. 1** ♂ The peat bog near Lago Nero (2395 m a.s.l., Passo Gavia, Central Italian Alps) provided seeds of *Pinus cembra*, dated  $6480 \pm 70$  a  $^{14}\text{C}$  BP, and pine branches. This tree was growing in situ on the peat bog margin during the Holocene Climatic Optimum. This is the highest timberline record so far known in the Italian Alps.