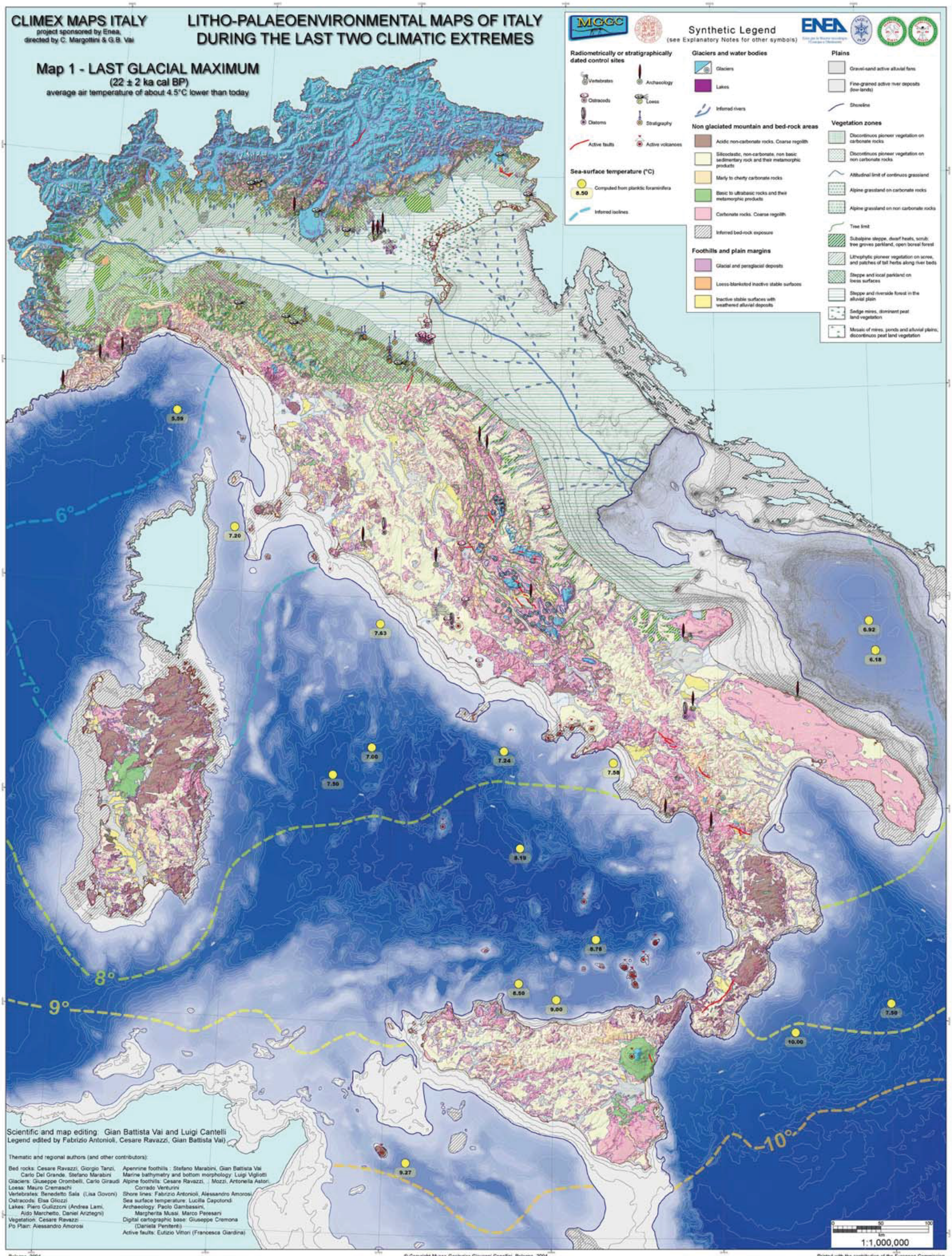

Bologna, 2004

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CLIMEX MAPS ITALY
project sponsored by Enea,
directed by C. Margottini & G.B. Vai
LITHO-PALAEOENVIRONMENTAL MAPS OF ITALY
DURING THE LAST TWO CLIMATIC EXTREMES
Map 2 - HOLOCENE CLIMATIC OPTIMUM
(8 ± 1 ka cal BP)
average surface air temperature of about 2°C higher than today
MGGC
ENEA
Synthetic Legend
(see Explanatory Notes for other symbols)
Radiometrically or stratigraphically dated control sites
Archaeology
12 Beaches
Ostracode
Stratigraphy
Diatoms
Active volcanoes
Active faults
Shoreline
Foothills and plains
Morenic arcs of Pleistocene age
Inactive stable surfaces
Undifferentiated inactive surfaces and active plains
Active alluvial plain of the Alpine-Venetian margin (partly calcareous sediments)
Active alluvial plain of the Apennine margin (mainly silicoclastic fine sediments)
Active alluvial plain of the Po river and its Alpine tributaries
Bay-head deltas
Lagoon/estuary
Glaciers and water bodies
Glaciers
Lakes
Vegetational zones
Discontinuous vegetation and grassland
Timberline
Forests, mires and salt marshes
Sea-surface temperature (°C)
Computed from spelean serpulids
12.82
Computed from planktic foraminifera
Inferred isolines
11°
12.00
12.15
12.82
12.62
14.00
13°
13.20
13.90
13.04
13.62
13.03
13.75
15.00
13.01
13.83
14.10
13.70
13°
13.92
17°
14.50
15.00
17.00
17.74
17.04
15°
16.01
16.09
17°
17.11
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Shoreline: Fabrizio Antonioli, Alessandro Amorosi
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UTM Projection, Zone 33
Bologna, 2004
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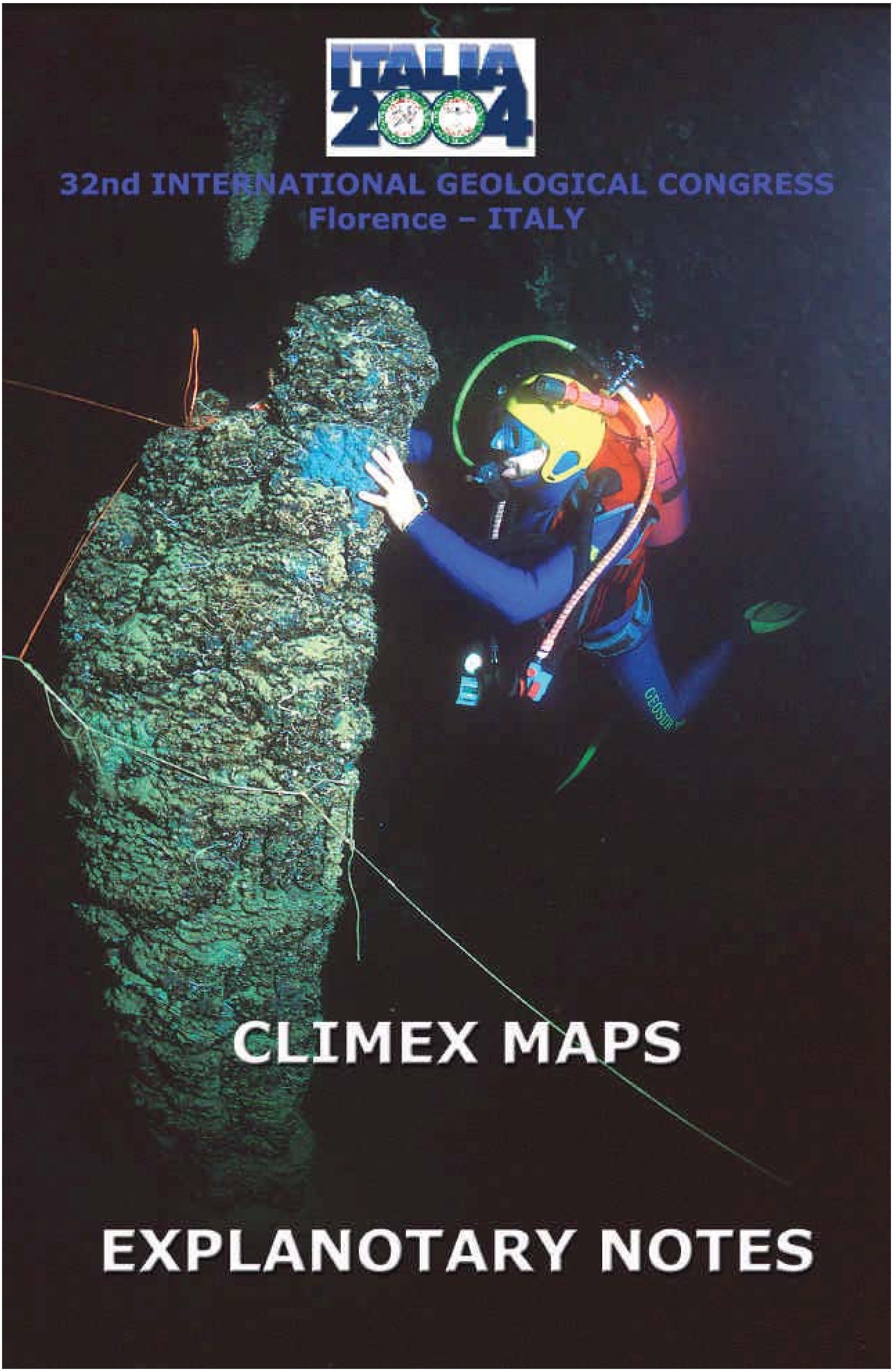
1:1,000,000



ITALIA 2004

32nd INTERNATIONAL GEOLOGICAL CONGRESS
Florence – ITALY

CLIMEX MAPS

EXPLANOTARY NOTES

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 ± 2 ka cal BP) average air temperature of about 4.5°C lower than today
Map 2 - HOLOCENE CLIMATIC OPTIMUM (8 ±1 ka cal BP) average surface air temperature of about 2°C higher than today
1:1,000,000 scale

EXPLANATORY NOTES

By

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SST from Serpulids overgrowths on Submerged Speleothems

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Introduction

In this session are abstracted SST proxy data for the Holocene Climatic Optimum (HCO ; 8 ka BP) as deduced by oxygen isotope data from Polychaeta serpulid overgrowths on speleothems. The samples were collected in three submerged caves located along the Tyrrhenian coast in Italy:

1) Cape Palinuro (Lat. 40.02°N – Long. 15.16°EGw)
2) Argentarola Island (Lat. 42.26°N– Long. 11.07°EGw)
3) Marettimo Island (Lat. 37.58° N– Long. 12°03 EGw).

Speleothems were collected by means of scuba diving to -21 m below sea level in the cave of Argentarola, down to -48 m in the cave at Palinuro and to –23 m in the cave at Marettimo; discussion and complete references on their using are available in Antonioli et al. (2001 and 2002).

Materials and methods

In the Tyrrhenian Sea, serpulids are typical dwellers of submerged caves, which offer a dark and sheltered environment, with restricted water flow.
Holocene serpulid colonies grown on submerged speleothems are typically 5 to 12 cm thick. At the time of sampling, the outermost layer of each colony was alive.
Optical microscopy observations coupled with Scanning Electron Microscopy allowed us to rule out diagenetic alteration of the Serpulid tubes and recognize the absence of dissolution voids and abiogenic cements. The growth patterns were also recognized: commonly, new individuals encrust the underlying dead Policheta, thus forming a dense colony of intertwined tubes. Serpulid colonies developed on continental speleothems when the rising sea level reached the speleothem tips. All the colonies have been constructed by the gregarious *Serpula massiliensis*, whose tubes consist of 100% calcite (Milliman, 1976), as confirmed by X-ray diffraction. Fossil *Serpula massiliensis* tubes also consist of 100% calcite, as determined by X-ray diffraction.

For d^{18}O reconstruction each subsample analized (2 mm wide) was powdered (average 4 mg), roasted in vacuum at 350° for 30 minutes to pyrolize organic matter and treated with 100% H_3PO_4 at 25°C for 6 hours. The CO_2 released by the reaction and purified by using a liquid nitrogen-ethyl alcohol slash at about -80°C, was measured in a Finnigan Delta mass spectrometer. Mean standard deviation of ?^{18}O measurements was typically ?0.1 ‰ (2?).
Radiocarbon dating was carried out on 11 colonies. ?^{18}O series were based on 9 colonies: 6 at Argentarola cave, 2 at Cape Palinuro and 1 in Marettimo cave (Alessio et al 1996, Antonioli and Oliverio 1996; Antonioli et al., 2001 and 2002).
The age at which serpulid colonies commenced growing was calculated by ^{14}C dating results and by using a mathematical model that assumes linear growth rates. The assumption is also based on the fact that the colonies do not show any apparent growth hiatus.
The model assumes that growth rates remained constant during the Holocene. The sample used for radiocarbon dating is a slab cut through the whole colony, from the fossil bottom to the living top. Conventional radiocarbon dating is thus carried out on a sample encompassing the whole time span through which the colony grew. The model allowed us to obtain the age of the bottom of the colony. The age thus obtained is correct only if there was constant growth. The mathematical method (Alessio et al., 1992) was, therefore, tested by AMS ^{14}C dating on the skeletons of the first marine dwellers (table 1) for the following samples: OS-2655 (Palinuro –27 m) and OS-2656 (Palinuro –41.5 m). AMS results yielded ages similar to those obtained through the model on the samples R-2358 (Palinuro –27 m) and R-2377 (Palinuro –41.5 m). Our assumption that growth rates remained constant, therefore, appears to be valid.
The validity of the model is supported by another AMS date obtained for the outermost layer of a stalactite (Argentarola cave, –18.5 m) in contact with the marine overgrowth.
The ?^{18}O data vs. time for each serpulid colony have been reconstructed through extrapolation from linear interpolation by assuming constant growth rate.

The outermost layers (active serpulids) from different colonies sampled in different caves and at different depths have a similar mean ?^{18}O value (2.1 ‰).
Polychaete serpulids are believed to secrete calcium carbonate close to ?^{18}O equilibrium with sea water and do not show metabolic effects on oxygen isotope fractionation (Videtich, 1986). The ?^{18}O value of serpulid tube calcite, therefore, should be a function of the ?^{18}O value of sea water and of the ambient temperature (e.g. O'Neill et al., 1969). Any discussion about variables which should be accounted for when interpreting the ?^{18}O signal of Tyrrhenian serpulids are in Antonioli et al. 2001.

Sea Surface Temperature reconstruction

If we assume that Tyrrhenian sea water ?^{18}O composition mainly reflects the SST variation, time changes in ?^{18}O of serpulid tube calcite could reflect SST trends (cooling vs. warming) averaged over about 200 years, which is the mean time span encompassed by a 2 mm^2 sample.
The measured present-day ?^{18}O value of sea water both within and outside the submerged caves is constant, and is 0.9 ‰ (SMOW). However, the SST measured within this submerged caves ranges from 17° in winter to 24°C in summer, and the SST outside the caves ranges from 14° in winter to 25° in summer. Cave waters are therefore less subjected to seasonal temperature variations, and can be considered as representative of average mean annual temperature. In the submerged caves at both Palinuro, Argentarola and Marettimo we did not record the presence of a thermocline. This physical characteristic of the coastal caves makes it possible to compare the ?^{18}O signals extracted from colonies sampled at different depths, and permits the assumption that serpulids long-term records of mean annual temperature changes of near-surface sea water averaged over 200 years.
Information on serpulid growth rates is available for harbour and brackish-water species (Bianchi and Morri, 1996), for which maximum tube growth occurs in summer. Faster growth rates during warm seasons were also documented for aragonite serpulids from a submarine cave off the coast of Belize (Videtich, 1986). Serpulids of tropical origin, such as *Serpula massiliensis* put most of their energy into reproduction in autumn and winter. They spend their energies to grow in summer, following their biological rhythm. Their annual growth rate is considered, however, constant as for other Mediterranean invertebrates, and independent from temperature. So we infer that serpulids commonly grew in summer throughout the Holocene, and that their growth rate was season-dependent, not temperature dependent, and that their calcite ?^{18}O signal records summer sea surface temperature trends within and outside the caves.
We exclude the possibility that ?^{18}O changes reflect the influence of karstic freshwater on the basis of the observation that *Serpula massiliensis* are not present in caves where there is freshwater percolation (Belloni and Bianchi 1982).
By application of Epstein et al. (1953) equation we calculated the SST-near-shore values for OPT map in these three sites of the Tyrrhenian Sea, as summarized in Tab. 1.

Location	Age (ky cal BP)	d ^{18}O (permil PDB)	SST (°C)
Argentarola Is.	7.81±1.77	1.37±0.39	14.5±1.6
Palinuro Cape	7.36±1.19	1.76±0.30	12.9±1.2
Marettimo Is.	8.00±1.64	0.80±0.72	16.9±3.0

Tab. 1. d ^{18}O and derived SST data shown in the HCO map.