CLIMATIC CHANGES DURING THE HOLOCENE: COMPARISON BETWEEN STABLE ISOTOPE, BIOSTRATIGRAPHICAL AND LITHOLOGICAL CLIMATE RECORDS IN FRESHWATER CALCAREOUS TUFA

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Accumulations of calcareous tufa in karstic regions represent unique archives of climate and land-use changes. Over large parts of Europe, from Britain to the Mediterranean and from Spain to the Czech Republic and Poland, the rates of tufa formation were high in early- and mid-Holocene, but declined markedly thereafter. The tufa mounds of the Bohemian Karst, a karstic region located in central part of the Czech Republic in the vicinity of Prague, show a similar pattern with most intensive tufa deposition during the climatic optimum of the Holocene. Dry climatic oscillations of late Atlantic and Subboreal, representing probably the most catastrophic climatic events of the Holocene, are recorded by the formation of talus horizons and/or horizons of humic soils.

We studied a 17 m thick calcareous tufa mound formed by karstic spring near the Svatý Jan pod Skalou Monastery in the Bohemian Karst, 25 km SW of Prague. The profile represents an internationally important Holocene stratigraphic site. The sedimentary profile studied in a hillside cut (upper segment), an excavated test pit (middle segment) and a borehole (lower segment) was dated by a combination of conventional ^{14}C dating of carbonate, AMS ^{14}C dating of charcoal, archaeological dating based on pottery fragments, U-series dating of carbonate and by fossil molluscan assemblages. The tufa mound was formed between about 8000 and 2400 y BP. The average accumulation rate was 0.3 m of tufa per century. After about 2400 y BP the spring started to discharge at the base of the mound and the tufa deposition was terminated.

Based on lithological boundaries 83 samples were taken from the whole sedimentary profile, each sample representing a thickness of about 20 cm. After cleaning and removal of clastic material, the samples were homogenized and analyzed for carbonate and organic matter content, $\delta^{13}C$ of carbonate (-7.9 to -10.5 ‰ PDB), $\delta^{18}O$ of carbonate (-7.3 to -8.3 ‰ PDB) and $\delta^{13}C$ of organic matter (-26.3 to -30.0 ‰ PDB). The obtained $\delta^{18}O$ record in carbonate was compared with oxygen isotope data from similar calcareous tufa profiles in Poland and $\delta^{18}O$ of ice cores from Camp Century, Greenland.

Good agreement between the Svatý Jan $\delta^{18}O_{carbonate}$ curve and the $\delta^{18}O$ ice core record from Camp Century indicates that the variability in $\delta^{18}O$ of carbonate was primarily controlled by changes in oxygen isotope composition of meteoric waters. This is corroborated by the fact that the spring today shows a virtually constant temperature throughout the year (11.3 to 11.6 °C), slightly higher than mean annual temperature, exhibits no significant seasonal variability in $\delta^{18}O$ of spring water and has a tritium activity corresponding to meteoric waters 5 to 15 years old.

The more or less monotonous $\delta^{13}C$ carbonate record in massive travertines from the lower part of the profile (Holocene climatic optimum) abruptly becomes more variable in the upper profile segment characterised by talus layers and fossil soil horizons. The isotopic and lithological trends are supported also by assemblages of fossil molluscs. The woodland molluscs characteristic for the lower part of the profile are gradually replaced by a richer assemblage (up to 46 mollusc species at the base of the upper isotopically variable segment of the profile) with both woodland and aquatic species.

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