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Holocene climate dynamics in the Eastern Italian Alps: a multi-proxy study from ice and peat bogs

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The Eastern Italian Alps are located near one of the areas in the world with some of the longest records of extreme environmental use by human activity. In this area, paleo-climate studies are hampered by the lack of high-resolution multi-proxy records with adequate chronological control. With this project, we propose to reconstruct Holocene climatic and environmental variations in the Eastern Italian Alps using terrestrial and glaciological archives. We aim to study the characteristics of different climate stages in this sector of the Alps using an ice core drilled on the top of the Ortles glacier (46°30' N, 10°32 E, 3850 m a.s.l.) and ombrotrophic peat bog records from the Dolomites (Danta di Cadore, 46°34' N, 12°33 E, 1400 m a.s.l. and Coltrondo 46°39'28.37"N 12°26'59.17"E, 1800 m a.s.l., Belluno province).

The study of global climatic change require a holistic and multi-proxy approach to better understand several complex and often non-linear relationships. In the Italian Alps our study on peat cores represents the first attempt where a multi-proxy approach is applied, and here we report our first results. A 7.0 m peat sequence was extracted in Danta di Cadore. The depth-age scale, based upon independent 14C and 210Pb dates and modeled with the Clam method (Blaauw, 2010), demonstrates that the archive covers more than 13,200 years (cal BP).
We determined physical proprieties, Ca and Ti trends, pore water pH, conductivity, and Ca/Mg ratios to identify changes in trophic conditions. The results confirm that the uppermost 400 cm are composed of ombrotrophic peat representing the longest Eastern Alpine ombrotrophic record yet obtained, covering the last 7,000 years.
The oldest radiocarbon age (13,200 years cal BP) provides evidence that, during the Bölling-Alleröd interstadial, the upper part of the Piave Glacier was ice-free up to 1400 m a.s.l.. At that time pollen assemblages show that a conifer forest characterized the local vegetation. This forest was then affected by the climatic cooling of the Younger Dryas, which caused an opening of the vegetation. The climatic amelioration occurring at the onset of the Holocene favored the local expansion of warmth-demanding species.
X-ray Fluorescence Core Scanner (XRF-CS) analysis was applied for the first time on Eastern Alpine peat sequences. XRF-CS signals were calibrated with ICP-MS, showing very high correlation and demonstrating that the XRF-CS technique provides reliable quantitative data. Results provide information about geochemical processes occurring in the bog.
The impact of mining activity was also evaluated. Concentration levels and enrichment factors (EFs) of several trace elements such as Pb, Ag and Cd correspond to the historical data about mining activities in the Cadore region.
Lead isotopes ratios were measured to identify natural and anthropogenic sources of Pb emissions. Results show an increase of Pb deriving from fuel combustion over the last decades that gradually overlie the impacts of mining activity. The decreasing 206Pb/207Pb trend reached its minimum value of 1.153 in the 1990s and then increased again. In these years, Italy started to follow EU rules to limit global pollutants in the atmosphere, and finally banned leaded fuels in 2002. Both 206Pb/207Pb ratio and Pb fluxes show a particular event between 1975 and 1980: this behavior is characteristic of the ILE (Isotopic Lead Experiment), a large-scale isotopic tracer experiment which was carried out in the Piedmont region (N-W Italy).
This multi-proxy approach that integrates, using new chronological insights, chemical physical and biological features of the core, improves our understanding of Eastern Alpine Holocene climate, helping to delineate biotic and abiotic responses to climate dynamics during the present interglacial.

Blaauw, M. 2010. Methods and code for 'classical' age modeling of radiocarbon sequences. Quarternary Geochronology, 5: 512-518.