The Adamello Glacier: paleoenvironmental and paleoclimatic variations at subannual resolution

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Paleoclimate and paleoenvironmental stratigraphic reconstructions from temperate glaciers are hindered by surface melting and ice metamorphism, which cause mobilization and concentration of impurities, as well as their interaction through englacial reactions.

Despite meltwater intrusions, other impurities such as pollen grains and other palynomorphs remain to their original depth of deposition thanks to their large grain-size. Temperate glaciers close to vegetated areas, therefore, can include palynomorphs of different types that i) can be reliable annual markers for ice-core dating and, ii) allow reconstructing paleoenvironmental changes through time.

The Adamello Glacier (Central Alps, Italy) is a temperate glacier that extends over ca 14.35 km² (2020) at elevations ranging between 2560 and 3420 m a.s.l. In the framework of the CLIMADA Project, a 224 m long ice core (ADA 270) was recovered in 2021 from Pian di Neve, the summit plateau at about 3200 m a.s.l. in the accumulation area of the glacier. Preliminary estimates date the surface ice of the glacier to the 1980s while the bottom of the core might be Medieval in age. Radionuclide-based dating (3H, 14C, 137Cs, 210Pb) is in progress.

The multiproxy approach adopted in this study includes black carbon, dust grain size and mineralogy, oxygen and hydrogen stable isotopes and palynomorphs, these last being the main object of this work. Given the site location, the palaeoecological signal is believed to be of regional significance.

Despite the stratigraphy may not be preserved for some soluble chemical species, the core contains a high variety of palynomorphs, which allow the reconstruction of palaeoenvironmental and paleoclimatic variations at subannual resolution. The mean ice accumulation rate is about 0.9 m w.eq. yr⁻¹. Consequently, the mean sampling resolution adopted for the palynomorph study is 0.1 m, increased to 0.01 m in specific intervals. Palynomorphs are mainly found in layers representing the spring-summer deposition while their concentration is very low during other
periods of the year. Pollen grains, spores, diatom frustules, phytoliths and charcoals characterize the spring-summer layers; glass shards of volcanic origin and green algae have been observed in few intervals. Sporadic but massive Saharan dust events, carrying characteristic dust particles and pollen of African provenance, were identified throughout the core. The comparison between these intervals and the historical “red rain” events in Northern Italy will help better constraining the ice core dating.

At ca 66 m depth, an ice interval characterized by a high impurity content has been investigated at 0.01 m resolution. Different palynomorphs are recorded in this interval, implying a quasi-continuous presence of humans and animals on the glacier for few years. Preliminary results link these layers to World War I, intensively fought between Italians and Austro-Hungarians on the slopes surrounding the Pian di Neve. The comparison between historical, archeological and ice core data allow delineating, at subannual resolution, the climate and environmental changes that characterized those years.