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# Validation and application of a novel, terrestrial biomarker-based paleo thermometer to Holocene sediments of Lake Cadagno, Switzerland

Helge Niemann (1), Stefanie B. Wirth (2), Alina Stadnitskaia (3), Adrian Gilli (2), Flavio S. Anselmetti (4), Jaap S. Sinninghe Damsté (3), Stefan Schouten (3), Ellen C. Hoppmans (3), and Moritz F. Lehmann (1)

(1) Institute for Environmental Geosciences, University of Basel, Switzerland (helge.niemann@unibas.ch, +41 61 2670479), (2) Geological Institute, ETH Zurich, Switzerland, (3) Royal Netherland Institute for Sea Research (NIOZ), Texel, the Netherlands, (4) Swiss Federal Institute of Aquatic Science and Technology (EAWAG), Dübendorf, Switzerland

Lake Cadagno is a relatively small (840 m long, 420 m wide, 21 m deep) lake that was created by glacial erosion at an altitude of 1921 m in the Piora valley in southern Switzerland. We recovered a 10.5 m long composite core from the deepest part of the lake, covering the entire sedimentary sequence of the last 11000 years. Our aim was to reconstruct past mean annual air temperatures (MAAT) using a novel, lipid-based proxy, the MBT/CBT paleothermometer. The MBT/CBT ratios comprise fossilised methyl-branched and cyclic Glycerol Dialkyl Glycerol Tetraethers (GDGTs) of presumably soil bacterial origin that are preserved in the lacustrine sedimentary sequence. The Lake Cadagno record consists of three different sediment types: Regular background sediments, flood deposits and intervals of reworked material (slump deposits). GDGTs were analysed from 10 cm thick sediment slices, which correspond to time intervals of 150 to 250 years. We excluded slump deposits from our analysis to avoid temporal biases in the MAAT record. Our results stand in good agreement with instrumental MAAT values for Lake Cadagno (ca. 0°C, Swiss Meteo). Furthermore, temperature variations recorded by the MBT/CBT paleothermometer match published temperature reconstructions for the last two millennia at nearby locations in timing and magnitude. Major climate anomalies recorded by the independent proxies and by the MBT/CBT paleothermometer are, for instance, the Little Ice Age (ca. 16th - 19th century; -0.4 °C), and the Medieval Warm Period (ca. 1000 years before present - yrs BP; +1°C). Furthermore, we detected a cold period lasting from about 2300 - 1800 yrs BP (-0.7°C), which correlates with the disappearance of the last lake dwellings in the European Alps. We also found cold periods during the Bronze Age (3500 - 4500 yrs BP; -0.5°C) and one at about 8000 yrs BP (-1°C), possibly corresponding to the so-called 8.2 Kilo Year Event. Sedimentological and GDGT analyses of Lake Cadagno sediments also yield indirect information on climate wetness in the catchment area. In alpine regions, strong rain falls typically lead to increased erosion and flood activities which are recorded in the sedimentary sequence (frequency and layer thickness of flood deposits). In addition, pronounced precipitation can induce leaching of basic elements (e.g. Mg, Ca) from soils, which shifts the soil pH towards more acidic values and thus has a pronounced impact on the CBT ratio. We found strongly enhanced flood activities concomitant with a decrease in soil pH of 0.3 units about 3500 - 4500 yrs BP. This putative evidence for a wetter climate during the Bronze Age agrees with earlier reports on alpine lake level stands, and is consistent with our paleotemperature reconstructions. We also found a shift in soil pH of about 1 unit towards more acidic values about 10000 years BP, which matches previous findings that suggest moist climate conditions at the end of the Younger Dryas and during the early Holocene.