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# 9800 years of meromixis and euxinia in Lake Cadagno (Swiss Alps): Sedimentary and biogeochemical evidence for the formation of a permanently stable chemocline

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Lake Cadagno is a meromictic high-alpine lake situated in the Piora valley in the southern Alps of Switzerland (1921 m asl, 0.26 km2, max. water depth 21 m). The inflow of sulfate-rich waters from subaquatic springs situated in dolomitic bedrock results in a permanent chemocline at 10 to 13 m water depth with sulfidic conditions in the hypolimnion. As yet, it is unknown how far back in time euxinia has prevailed in the Lake Cadagno water column, maintaining a diverse anaerobic community of bacteria at and below the redox-transition zone.
Long sediment cores (10.5 m) covering the past ∼12,000 years were, for the first time, retrieved from the centre of Lake Cadagno using an UWITEC piston coring system. Here, we present results documenting the lake's redox-state evolution through the Holocene based on sedimentological, geochemical and molecular analyses.
Sediment stratigraphy reveals an autochthonous lacustrine background sedimentation frequently intercalated by flood (accounting for 30% of the sediment succession) and mass-movement deposits (49%) that are the result of lake-slope failures. Trace metal analysis by XRF core scanning and ICP-MS measurements document the transition from oxic conditions after the lake formation (∼12,000 cal yr BP) to the onset of sulfidic conditions at ∼9800 cal yr BP. Enhanced accumulation/preservation of Mn (up to 5.9 wt% of Mn) in the sediments indicates an intermediate (i.e. manganous) oxygenation state with fluctuating redox conditions during a millennial transition period. We propose that the high Mn concentrations are the result of Mn2+ leaching from the sediments during reducing conditions and subsequent rapid precipitation of Mn-oxide minerals during episodic and short-term mixing events. Sulfidic conditions, which are indicated in the sediment record by high Mo burial rates (Mo concentrations of up to 470 ppm), prevailed thereafter until modern times without any lasting hypolimnetic oxygenation.
We speculate that the onset of euxinia in Lake Cadagno corresponds to the actuation of subaquatic springs originating from dolomitic bedrock after the last glacial termination. This result of a stable and persistent chemocline offers a framework to study over ∼10 kyr the evolution of anaerobic bacterial communities in an extreme lacustrine environment that possibly resemble conditions more common in ancient oceans.