

Preservation and climatic forcing of non-annual Fe-Mn sediment laminae in Lago Fagnano, Tierra del Fuego

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Lago Fagnano (54° S Tierra del Fuego, Argentina/Chile) is the southernmost ice-free lake outside Antarctica and, as such, a gateway to understand past and present relations between Antarctic, South Pacific and South Atlantic climate changes. The sediments exhibit a cyclic alternation of light clay and dark green to black laminae suggesting a well-stratified lake under certain environmental or climate conditions. However, currently extreme westerly winds impact Lago Fagnano the whole year promoting lake mixing especially during austral summer. Here we aimed at clarifying the mechanism and climatic forcing of laminae formation in Lago Fagnano under well-mixed and oligotrophic conditions. Using high-resolution XRF scanning and mapping, thin section, XRD and SEM analyses of sediment cores, we identified Fe- and Mn-oxides as triggering the lamination in a non-annual pattern. Two types of lamination are observed in the Holocene sediment sequence of Lago Fagnano: (1) a coarse, cm-scaled lamination in the western sub-basin, characterised by a very low sedimentation rate of ~ 0.1 mm/year and a frequency of ~ 52 years, and (2) a fine, mm-scaled lamination observed in the eastern sub-basin of the lake, with higher sedimentation rate (~ 0.5 mm/year) and with light-dark laminae couplets that appear more frequent (on average every ~ 4 years). We propose that a rapid increase of sedimentation due to higher runoff or mass wasting events promotes the burial and preservation of oxidised Fe-Mn laminae in Lago Fagnano. Increased runoff is related to the strength of the Southern Hemisphere Westerlies. The cyclic repetition of the buried Fe-Mn laminae, occurring every ~ 52 and ~ 4 years in the western and eastern sub-basins, respectively, suggests a forcing mechanism related to climate variability, potentially the Antarctic Oscillation and/or the El Niño Southern Oscillation.