PALEOHYDROLOGY AND HUMAN IMPACT INFERRED FROM SEDIMENTARY FACIES ANALYSES: THE LAGUNA ZOÑAR RECORD (ANDALUCIA, SPAIN)

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THE LAKE AND THE WATERSHED

The climate is a subtropical Mediterranean, with an average annual rainfall of about 540 mm (350 mm during dry years) and with an annual evapotranspiration estimated over 1500 mm. (A) Laguna Zoñar (37°29'00" N, 4º41'22" W, 300 m a.s.l.) is the deepest (up to 14 m), sea bathermally in D and largest (27 km²) surface area of the 10 lakes belonging to the Natural Park of Southern Córdoba (Andalucía, Spain). The lake is monomictic; waters are saline (2.4 ± g/L) and of (Cl−)-(SO4²−)-(Na+) type. The lake is mainly fed by springs located in the E and S margins, and there is one non-functional surface outflow. The main spring is located in the Torbernian limestone. (C) A seismic survey (E) shows the steep lake margins and the Aynoa del Loto delta (F), but there was no sediment penetration.

THE SEDIMENT RECORD OF PAST CHANGES

Eight sedimentary facies have been identified after integrating visual description, smear slide observation and sediment composition analyses. They group in two facies associations: Facies Association A integrates cm-thick, massive, laminated facies of Units 1, 3 and 4. Facies Association B includes finely laminated and organic-rich (F. 2 and 5) units, cm-thick, massive, calcite mud facies. Facies Association A represents deposition during periods of variable, but significant clastic input from the lake and fluvial creeks. Increased sediment input from the creeks could respond to increased river flow and rainfall and/or changes in the land uses, including the loss of the littoral vegetated area. The absence of laminae in the sediments indicates intense bioturbation activity, and likely frequentoxic conditions in the water column till the bottom of the lake. Facies Association B represents deposition in Zoñar Lake during a period of a more restricted clastic input from the creek. Preservation of laminae indicates absence of bioturbation, most likely provided by erosive bottom water conditions. Diatom blooms and "carbonate whitings" are absent in the green and white laminae respectively. Rare flooding episodes deposited thin clay-rich gray facies. These variegated, organic-rich laminated facies are interpreted as the result of deposition during a period of relatively higher water concentration, when Zoñar Lake did not have a surface outflow and the average lake level was lower.

THE LAKE HISTORY

The watershed has been intensively farmed during centuries. Hydrological records indicate the lake was deeper in the late 18th century. The only surface outflow to the Cabriel River was destroyed to gain the surrounding arable land and was partially the Zoñar Lake during the late 18th and early 19th centuries, during the period of Tambería and Tormo. This period characterizes the Zoñar Lake during human usages, and the lake levels dropped even more. Since the beginning of the 20th century, the surface outflow recovered and large littoral areas were submerging. The surface outflow was closed but it was non-existent, so today, the lake has no surface outflow.

CHANGES IN THE PAST

During the period 1985-2000. B. Relationship among water input (rainfall and spring flow) and lake level during 1987. The lake was protected in the early 1980s, lake level was raised, and the lake size decreased. The Zoñar core A spans from medieval to recent times. Average sedimentation rate is about 2 mm yr⁻¹. The 210Pb activities measured in a parallel core (see above) range between 0.669 and 1.343 pCi g⁻¹. The 210Pb/214Bi activity ratio measured over the lake core is very high, between 0.669 and 1.343 pCi g⁻¹. These low values are somehow unexpected in a semi-humid region could be related to dilution of the atmospheric 210Pb by high activities of other nuclides. The compensation of low sedimentation rates and rare flooding episodes deposited thin clay-rich gray facies. These variegated, organic-rich laminated facies are interpreted as the result of deposition during a period of relatively higher water concentration, when Zoñar Lake did not have a surface outflow and the average lake levels were lower.