Sediment dynamics and producticity in two chilean lakes: Climate archive versus geodynamic activity

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During the past decades lacustrine systems in Chile have been in focus for various multiproxy studies concerning large-scale patterns of climate variability. High-resolution studies on Holocene development on a millennium time scale in terrestrial and lacustrine archives provided information of abrupt climate changes like the „Medieval Warm Period" or "Little Ice Age" events (e. g. Villalba, 1994; Jenny et al., 2002; Glasser et al., 2004; Grosjean et al, 2003). As lake sediments have become an important tool to document and reconstruct the variability of environmental systems and the extent of climatic changes, the quality and resolution of lacustrine sedimentary archives have to be critically tested. Most of the environmental and climate proxies, used in paleoclimate studies are also sensitive to geological and atmospheric disturbances outside a given lake system. Such disturbances, like volcanic activity, tectonic movement etc. may overwhelm the signals that reflect e. g. changes in moisture and precipitation rates.

The Chilean Lake District is subject to continuous volcanic and neotectonic activity due to Chiles' active continental margin and the subduction of the Nazca plate. Lake Calafquén and Lake Villarrica are located in the northern part of the Lake District, at the flanks of active volcano Villarrica. This active geodynamic setting with intense volcanism and strong earthquakes routinely influences the clastic sedimentation of both lakes. Catchment erosion, tephra fallout deposition, lahars, large subaquaeous mass movements, rock falls and sliding events intensively influence the sedimentation processes in the lakes. Their influential effects have only recently started to being studied in detail.

Based on high-resolution seismic surveys, multiproxy studies with short cores were conducted within the two lakes, using magnetic susceptibility, grain size, geochemistry, total carbon, biogenic silica and diatom assemblages. These parameters show a significant resonance to the frequent volcanic and seismic events within and around the lake basins. Performing a paleo-climate reconstruction, based on the interpretation of the proxy-results from the sediment archives of these lakes seems not to be adequate and should be assessed carefully. The intense volcanism in this area masks the response of the terrestrial and aquatic system to other environmental and climatic changes. Furthermore seismic shock events, like frequent strong earthquakes, occurring in this area, favour large sliding and rock fall events. As well mass movements and continuous soil creeping disturb and falsify the natural lacustrine sedimentation processes. Those effects are therefore considered and evaluated in detail. They lead to the assumption that paleoproductivity and sediment accumulation rates cannot reliably trigger paleoenvironmental and climatic signals in this region. Consequently, the archive potential of these lakes is believed to be not suitable to use it as a database for environmental and climatic reconstructions.

GLASSER, N.F., HARRISON, S., WINCHESTER & V., ANIYA, M. (2004) Late Pleistocene and Holocene palaeoclimate and glacier fluctuations in Patagonia. Global and Planetary Change, 43, 79-101.

GROSJEAN, M., CARTAJENA, I., GEYH & M.A., NUNEZ, L. (2003) From proxy data to paleoclimate interpretation: the mid-Holocene paradox of the Atacama Desert, northern Chile. Palaeogeography Palaeoclimatology Palaeoecology, 194, 247-258.

JENNY, B., VALERO-GARCÉS, B.L., URRUTIA, R., KELTS, K., VEIT, H. APPLEBY, P.G. & GEYH, M. (2002) Moisture changes and fluctuations of the Westerlies in mediterranean Central Chile during the last 2000 years: The Laguna Acuelo record (33°50'). Quaternary International, 87, 3-18.

VILLALBA, R. (1994) Tree-ring and glacial evidence for the Medieval Warm Epoch and the Little Ice Age in southern South America. Climate Change, 26, 183-197.