The presence of a distinct negative Ce anomaly reflects an important characteristic feature of seawater. In modern seawater, the progressive Ce anomaly with depth is attributed to the scavenging of Ce due to oxidation to Ce 4+ and its incorporation into Mn and/or Fe oxyhydrides (Shaw & Wasserburg, 1985) or to its enrichment in authigenic minerals. The extent of Ce depletion in seawater does not solely depends on the oxidation potential (German & Elderfield, 1990), but also on microbial activity that catalyses the oxidation of Ce III (Moffett, 1990), as well as the pH (Shield et al., 2001), depth (Piepgras and Jacobsen, 1992), and age of the seawater (German & Elderfield, 1990). In our case, PS22 shows a negative Ce anomaly (-0,44) pointing to a relatively deeper water depositional environment, while others variables (positives Ce anomalies) may broadly reflect local bottom-water redox conditions. The higher Fe oxide contents in Lefipan compared to Gaiman's ones also suggest that an induced flocculation has taken place as a result of water mixing zones. We interpret the Rees behavior in Lefipan concretions as linked to estuarine coastal setting, as also suggested by Olivero and Medina, (1993) who interpreted that depositional environmental range from estuarine barrier island (lower part) to deltaic (upper part). This original pattern was modified by early diagenesis which caused the Rees remobilization and later enrichment given the bell- shape pattern.
Lefipan concretions (Maastrichian-Paleocene) have higher Rees total contents than Gaiman ones (Late Oligocene-Early Miocene), corroborating the results given by several authors (Jarvis et al. 1994, Mc Arthur and Walsh, 1984) who pointed out that Rees contents increased with the age.

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GEOPHYSICAL RECONSTRUCTION OF THE SEDIMENTARY INFILL OF LAGO ICALMA (39°S, CHILEAN LAKE DISTRICT) SINCE THE LAST DEGLACIATION 7-02

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Summary

The sedimentary infill of Lago Icalma (Southern Chile), encompassing a part of the last glacial and the post-glacial episode, was investigated by high-resolution (sparker) and very high-resolution (3.5 kHz) reflection seismics. A seismostratigraphical approach led to the subdivision of the approx. 115 m-thick sedimentary sequence into four units. The presence of a major erosional unconformity within the infill and a repetition of the sub-glacial to ice-proximal facies (three times) near the outflow of the

Rio Rucanuco suggest that the area may have witnessed two glacial readvances during the last deglaciation. The evolution of depocentres of these different units allows us to better understand the related sedimentary processes.
The high-resolution seismic data and physical properties measured on two 8 m-long piston cores show a very important proportion of instantaneous deposits (~23%) within the uppermost units (4c). The strong seismo-tectonic activity is characterised, in the lacustrine infill of the main basin, by mass-wasting deposits located at the foot of basin slopes. A second type of mass-wasting deposit, triggered by heavy rain falls, occurs at the vicinity of incised canyons of the northwestern flank. Thus, major destabilization events and strong volcanic activity are the main forcing factors controlling sedimentation since the last 8000 yr cal. BP.

Abstract text

Most studies of volcanism, seismicity, deglaciation and climate change in the Chilean Lake District have up to now focused essentially on soils, moraines, peat bogs, ponds, small peri-glacial lakes and oceanic sediments, but their record enclosed in the numerous large lakes that are so characteristic of the area is yet to be explored. Nevertheless, several multidisciplinary investigations of lacustrine records in the world have shown that such records can yield very detailed paleoenvironmental reconstructions: e.g. Lake Annecy (Oldfield et al., 2001), Lake Cardiel (Markgraf et al., 2003), Lake Miscardi (Ariztegui et al., 2001), and Lake Titicaca (d'Agostino et al., 2002). With this work, we want to present the first results of a seismic investigation of *Lago Icalma*, in an attempt to examine the potential of its sedimentary infill to contain a paleoclimatic record, and also to quantify various forcing factors (volcanism, seismicity), which left their imprint on the lacustrine infill.

Lago Icalma is located in the North of the Lake District area (*Araucania* region, *Cordillera de los Andes*; 1140 m), in the upper part of the *Bio-Bio* river watershed (Fig. 1). Together, with nearby *Lago Galletue*, it forms the source of the *Bio-Bio River*. *Lago Icalma* is not a piedmont lake like most other lakes of the Lake District. It is formed by two connected flat basins: *Laguna Chica*, on its western part, and *Lago Icalma s.s.* on its eastern part. These are separated by two glacial rock bars (Fig. 2). This relatively small lake can be considered as the infill of an overdeepened glacial valley. The main inflowing rivers are *Rio Huillinco*, entering the lake from the main glacial valley, and *Rio Icalma*, forming the main delta. The lake border at its outlet coincides with a frontal moraine, but the lake is not really moraine-dammed. The successive frontal moraines are cut by the outflowing river*, Rio Rucanuco*.

Lago Icalma is surrounded by several active volcanoes (Llaima, Lonquimay, Navidad, calderas Sollipulli) and calderas of Plio-Pleistocene age (Pino Hachado and Meseta del Arco). Its watershed is dominated by a thick (~ 4 to 6 m) soft post-glacial sediment cover, composed of volcanic amorphous material (glass and allophane), interrupted by two important pumice layers (Mardones et al., 1993, Bertrand et al., submitted). The upper pumice layer, dated 3045 yr cal. BP, was also found in the two piston cores (Fig. 4), and can be considered as an excellent spatial isochrone.
Lago Icalma is also located in a tectonically active region (Suarez & Emparan, 1997). Active basement faults, recognised along the lake shores, continue into the main lake basin and into the *Laguna Chica* (Fig. 2) and have locally deformed the sedimentary infill. The valley and the lake seem to follow the fault line which has allowed the diffluence of a glacial tongue from the ice flows in the Icalma and Huillinco valleys, but also from the Tacura valley (Mardones and al., 1993). Moreover, Lago Icalma is only 20 km from the North-South Aluminé Fault, which more or less coincides with the Chile-Argentina border, and represents an important structure that shapes the morphology of the entire area.

During the austral summer 2001/2002, about 105 km of high-resolution seismic data were recorded using high-resolution (RCMG's "Centipede" comb-type sparker) and very high-resolution seismic sources (3.5 kHz) (Charlet et al., 2003). The sparker signal penetrated the entire sediment fill with a resolution of about 50 cm in the upper layers. The 3.5 kHz source penetrated the upper 15 m with a very-high resolution of about 20 cm.

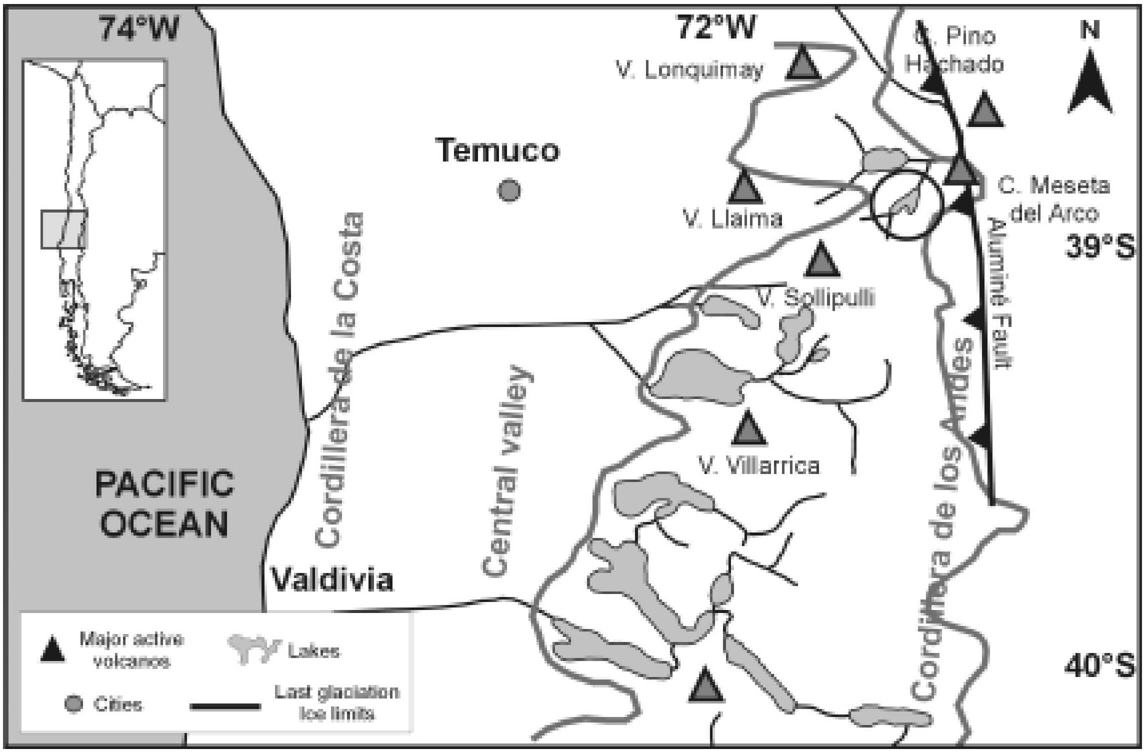

Fig.1 - General location of Lago Icalma in the northern part of the Lake District. The map also shows the maximum extension of the Patagonian Ice cap during the Last Glacial Maximum (LGM) (29-16 ka, Denton et al., 1999).

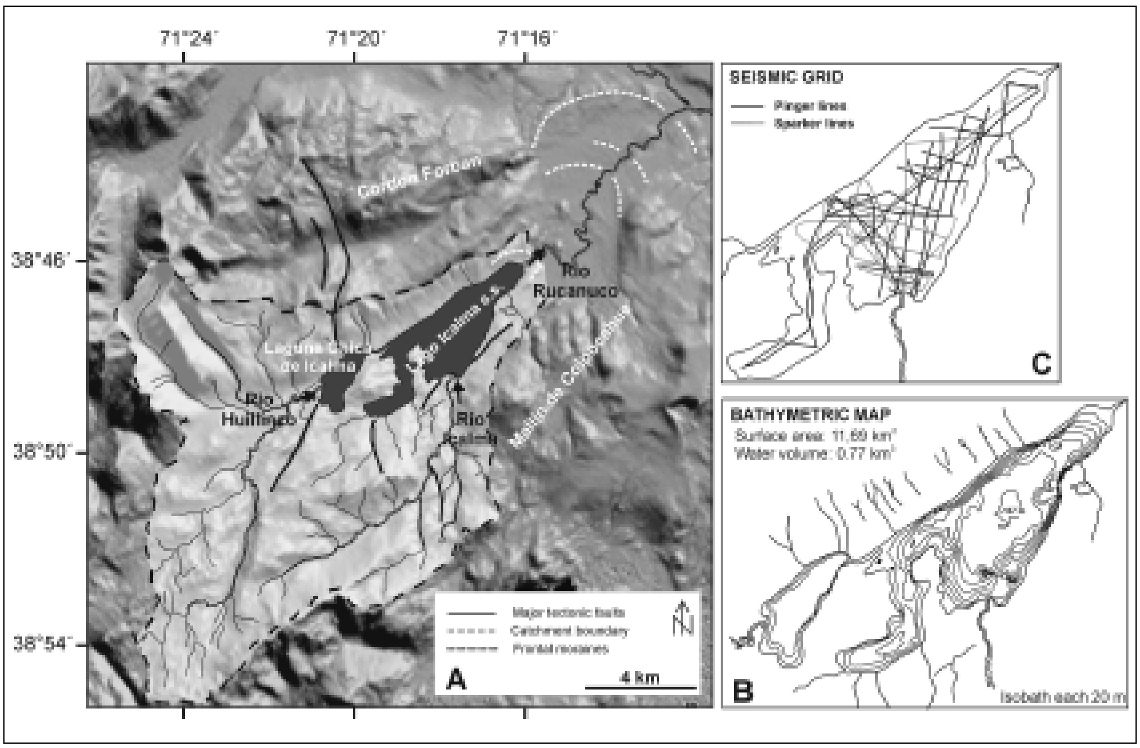

Fig. 2 - A) Detailed setting of Lago Icalma and its surroundings showing the glacial imprint (moraines, glacial-rock bars) on the geomorphology. B) Bathymetric map based on integration of seismic data and published data for *Laguna Chica de Icalma* (Parra et al., 1993). C) Seismic grids (sparker and 3.5 kHz) used for mapping.

The infill of Icalma basin is fully imaged by the sparker data and consists of four main seismic units separated by unconformities (Fig. 3). The succession resembles the typical infill of other glacial lakes (Van Rensbergen et al., 1998). The units are named unit 1 to unit 4 from the bottom to the top:

Unit 1 is an assemblage of chaotic to irregularly stratified seismic sub-facies occuring at the base of the basin fill (Fig. 3). This unit reaches a maximum thickness of 15 ms TWT. As a whole, Unit 1 is interpreted as glacially derived sediment (glacial moraine), deposited on the onset of the deglaciation of the basin.
This unit has been identified at different levels within the sedimentary fill (Unit 1a, Unit 1b & Unit 1c), which suggest that the basin has experienced glacial conditions during three successive times. The spatial distribution of these units shows depocentres toward the lake outflow (*Rio Rucanuco)*.

Unit 2 is a mostly reflection-free basin fill, characterised by low-amplitude reflectors. It represents the most voluminous unit with a maximum thickness of 65 ms TWT. It can be interpreted as glacio-lacustrine deposits (sub- to pro-glacial). As Unit 1, Unit 2 has been identified at different levels within the sedimentary infill (Units 2a, 2b & 2c).

The unusual distribution and repetition of units 1 & 2 suggests two main pulses of the glacier since the last deglaciation.

Unit 3c as a whole is an onlapping basin fill with parallel continuous reflections, interpreted as the result of lacustrine sedimentation dominated by strong sediment-charged underflows originating from the lake tributaries (large floods). It reaches a maximum thickness of 47 ms TWT.

Unit 4c is the topmost unit, characterised by parallel, sub-horizontal reflections concordant with the underlying deposits. It reaches a maximum thickness of ~40 ms TWT. Unit 4c is composed of a depocentre in the deepest part of the lake, corresponding to the "underflow" area. Another important depocentre occurs on the north-western elevated platform and possibly represents the "interflow" deposits, which are deflected to the left as a result of the Earth's rotation (Van Rensbergen et al., 1999).

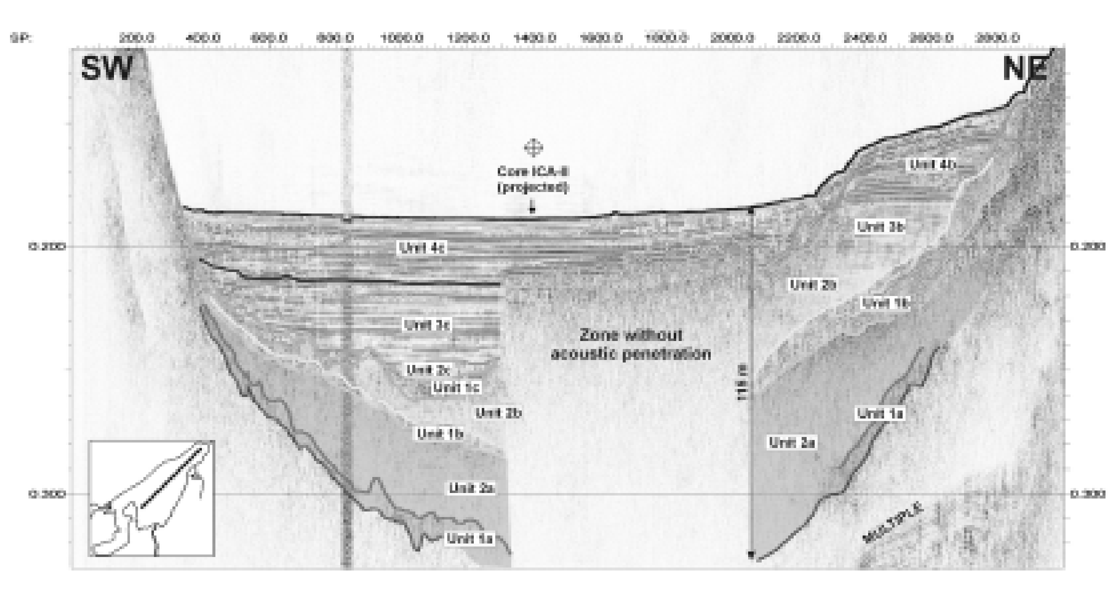

Fig. 3 - Longitudinal sparker profile of Lago Icalma (ical01) showing the 115 m-thick sedimentary infill and the seismic units together with a zone without acoustic penetration (gas).

Based on the very high-resolution seismic data and on the physical property measurements, the upper part of unit 4c can be further subdivided into four main sub-units (SU 4c1, 4c2, 4c3 and 4c4) (Fig. 4). These sub-units are composed of 3 main facies types:

1) High amplitude and homogenous chaotic facies: depocentres are located at the vicinity of the canyons, along the steep western slope or at the foothill of the main basin slopes. This facies is interpreted as accumulation of destabilized sediment, triggered by heavy rains falls or seismo-tectonic events.
2) High amplitude and irregular stratified facies: depocentres are concentrated in the deepest part of the lake, close to the delta. These deposits are interpreted as flood deposits resulting from underflows coming from the delta, during periods of strong precipitation (Van Rensbergen et al. 1999, Chapron et al., in review).
3) Medium to high-amplitude reflectors constituting a stratified facies (forms essentially SU 4c4): depocentres are located on the western part of the lake and on the small high separating the two connected basins. This seismic facies drapes the morphology and can be considered as interflow deposits.
The contemporaneous sedimentation also shows a strong imprint of volcanic activity, identified by very high peaks of magnetic susceptibility (Fig. 4). The many active volcanoes surrounding Lago Icalma hamper the identification of the exact volcanic source for each volcanic deposit identified with the core.

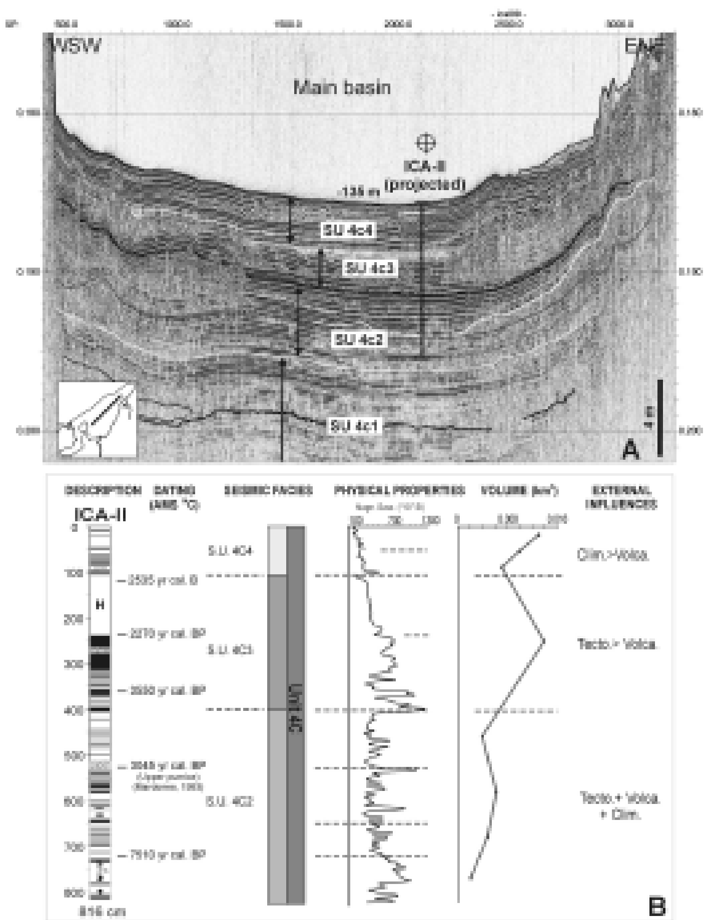

Fig. 4 - A) Very high-resolution pinger profile (ical09) showing the position of piston core ICA-II, the upper unit 4c and its further sub-divisions, as defined respectively from the sparker and pinger data. B) Core description, ^{14}C AMS dating and magnetic susceptibility measurements allow the subdivision of these units into several sub-units affected by different depositional processes.

Thus, based on sparker seismic data, the successive facies are interpreted as the deglaciation evolution in the drainage basin since the LGM. A further subdivision of the interglacial fill, which could be achieved thanks to the 3.5 kHz seismic data, reveal a strong combined tectonic/volcanic imprint, leaving few indices of paleoclimatic fluctuations. However, the clastic input seems to fluctuate significantly during the middle and upper Holocene.

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HOLOCENE CARBONATE SEDIMENTATION IN THE NORTH WESTERN SECTOR OF THE MAGELLAN STRAIT: TEXTURAL, GEOCHEMICAL AND MICROPALEONTOLOGICAL PRELIMINARY RESULTS 7-03

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In this paper we propose textural, geochemical and micropaleontological preliminary results on six gravity cores collected in the North Western basin of the Magellan Strait (Fig. 1) during 3 oceanographic cruises in 1991 (MB91-47; MB91-57R) and 1995 (MG95-2; SS95-6; SS95-9; SS95-10). These cruises were carried out in the framework of the Programma Nazionale di Ricerche in Antartide (P.N.R.A.).

Fig. 1 - Location of cores.