San Valentin glacier ice core (Chilean Patagonia) – Filling the gap between Central Andes and Antarctica

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Introduction

For the last 30 years, ice core investigations along the Andes have been mainly focused in the Central Andes, between the equator and 30°S. Major paleoclimate reconstructions covering the last 25,000 years were obtained from Quelccaya, Huascaran, Sajama (Thompson, et al., 1998), Illimani (Ramirez, et al., 2003) and Cerro Tapado (Ginot, et al., 2006). South of 60°S, from the Antarctic Peninsula to the South Pole, the international ice core community is investigating numerous and widespread paleoclimate records, providing longer timescales. In order to understand the connection between tropical areas and high latitudes, we have set up a new ice core deep drilling program in the Chilean/Argentinean Patagonia, at 47°S, on San Valentin and San Lorenzo summit glaciers (see project description).

San Valentin ice core drilling project

A first 16-m-long shallow ice core was extracted in March 2005 from San Valentin glacier (Fig. 1) where radar sounding indicates a glacier thickness of about 170 m (G. Casassa, pers. com.). The firn temperature measured at 16 m depth is -12°C, confirming the excellent paleoclimate signal preservation at this high altitude site. The ice core stratigraphy reveals no surface melting/refreezing ice layer. No ash or dust layer has been observed. The ice has been analyzed for ionic contents, water stable isotopes (δD and $\delta^{18}O$) and some radio-nuclides. ^{210}Pb decay and ^{137}Cs peaks indicate a time range of about 1965 to 2005, which corresponds to a mean annual accumulation rate of about 33 cm of snow per year (180 mm water equivalent). The chemical concentrations measured along the profile are extremely low, comparable to polar levels (Fig. 2). Their main

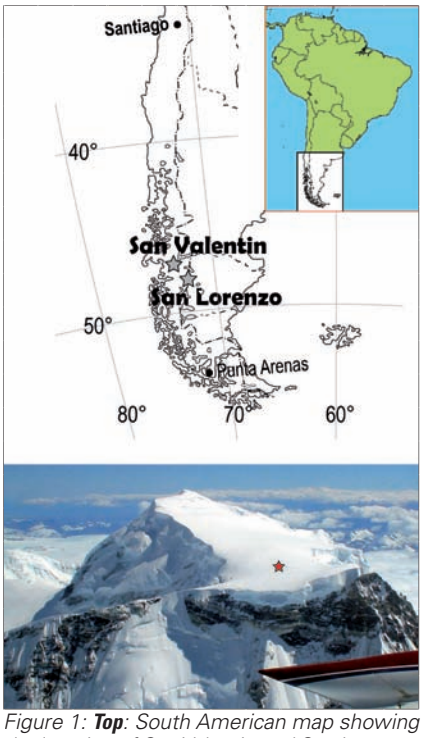

*Figure 1: **Top**: South American map showing the location of San Valentin and San Lorenzo. **Bottom**: San Valentin summit glacier (photo taken from plane) showing the location of the March 2005 shallow ice core drilling site.*

feature illustrates that the chemical profile is well preserved from water percolation alteration. The seasonal variations of some chemical concentrations (e.g. nss-Ca^{2+}) allow annual layer counting, in agreement with the radio-nuclide dating. Some specific events are recorded: (i) Oceanic aerosol deposition, marked by sea salt peaks associated with biogenic sulfate and MSA (Methanesulfonate), were found at several depth levels (e.g. surface, 3.8 m, 7.6 m); the Cl^-/Na^+ ratio profile, generally close to the oceanic sea salt ratio, indicates rapid aerosol transport; (ii) Biomass burning events characterized by high nitrate concentrations associated with nss-Sulfate and/or nss-chloride increase were observed. The strongest event is located at 11.1 m. These two different types of events may be related to the two main atmospheric circulation regimes: westerlies (oceanic input) or atmospheric transport from Argentinean Patagonia (fire plumes). Further investigations are needed to deconvoluate the sulfur signal, and so, to locate the main volcanic eruptions over this time period (e.g. Cerro Hudson 1991). The water stable isotope content (δD, $\delta^{18}O$) of the ice was measured with a twice-lower sampling resolution, which does not allow us to clearly distinguish the seasonal variations (Fig. 2). However, the dry/wet season alternation, as revealed by the aerosol profiles, matches the narrow peaks in the isotopic profile. Moreover, the isotope profile exhibits an interesting interannual signal that should be further discussed. Deuterium excess has also been calculated (not shown). The $\delta D/\delta^{18}O$ slope is 8.64, confirming that no melting at the surface occurs. Deuterium excess exhibits a large range from about 4 to 18‰, strongly suggesting large fluctuations in airmass origins and trajectories. This is in agreement with what has been inferred from chemical profiles.

The promising results from this preliminary study have lead us to plan deeper drilling operations in this area in April/May 2007. An ice

Project facts:

The Sanvallor project deals with two deep ice cores at San Valentin glacier (Chile, 3747 m, 46°35'19"S, 73°19'39"W) and San Lorenzo glacier (Chile/Argentina, ~3500 m, ~47°32'S, 72°20'W). It started in 2005, with the preliminary study on the shallow core, and should run until 2009. The preliminary study was funded by IRD-Great Ice, LSCE, LGGE and CECS Valdivia (Centro de Estudios Cientificos). The first deep drilling operations attempt was funded by the Chilean Fondecyt and IRD. A proposal has been submitted to fund the analyses.

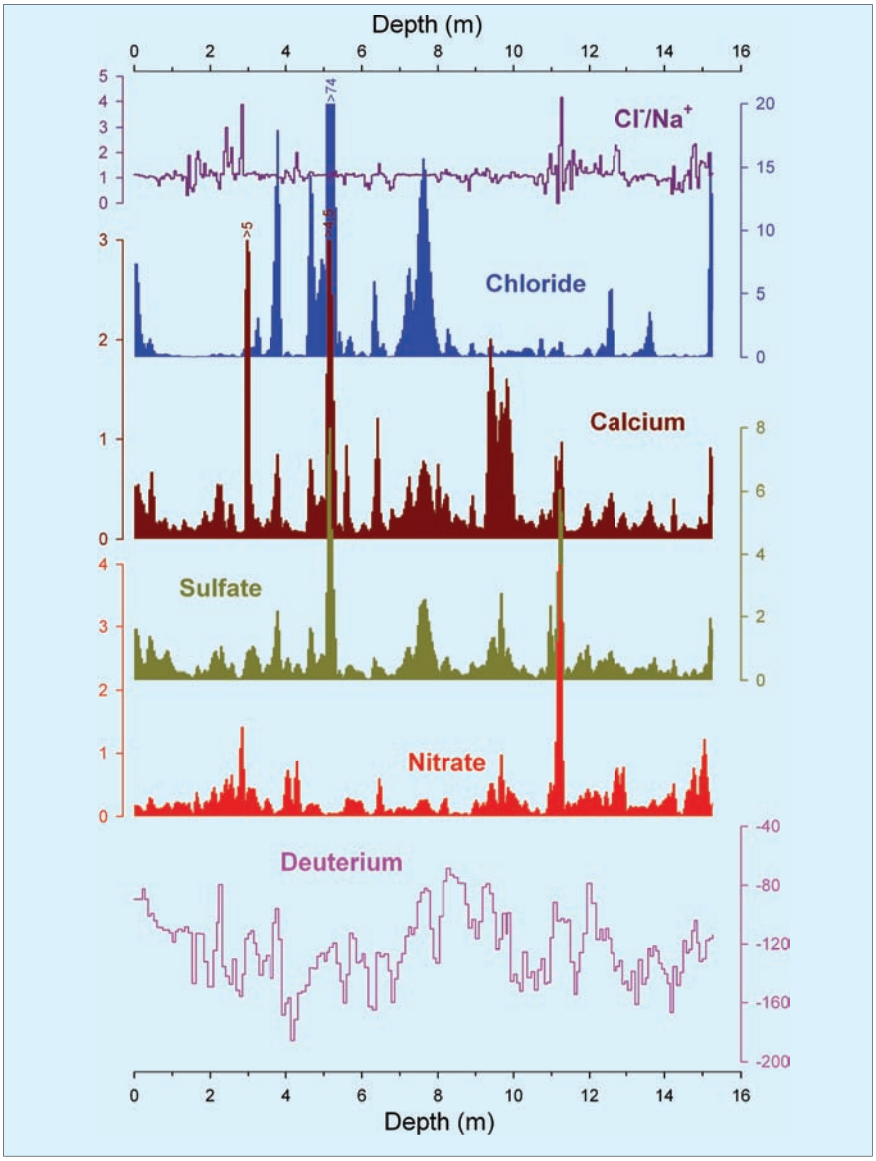

Figure 2: Selected chemical concentration (µEq.L⁻¹), ratio and δD (‰ versus SMOW) profiles measured along the San Valentin 16-m-long shallow ice core extracted in March 2005.

core will be recovered down to the bedrock by IRD Great Ice and its partners on the San Valentin site, and some preliminary investigations performed on the San Lorenzo glacier, about 50 km farther southeast. Ice thickness and estimated accumulation rate on San Valentin allow us to expect paleoclimate reconstructions at high resolution over, at least, the last 2000 years. The deepest part of the ice cores might include the Last Glacial Maximum. Ice will be dispatched to all the participating laboratories. The ice core diameter will permit us to provide enough material to establish all the profiles with the required resolution.

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Sediment, pollen and isotope evidence for an Early to Mid-Holocene humid period in the desert of Yemen

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Introduction

Environmental reconstructions of tropical deserts during the Holocene have mainly focused on Northern Africa. There, numerous lake-level and pollen data have been extensively used for regional reconstruction of past hydrological or vegetation changes, as well as for paleoclimatic models connecting environmental changes with variations in the Earth's orbit or investigating atmosphere-vegetation feedback in the climate system. By contrast, very little is known about the environmental and climate history of Arabia, even though recent discoveries of speleothems in Oman (Fleitmann et al., 2003) have yielded high-resolution oxygen isotope records reflecting variations in the Indian monsoon rainfall during the Holocene. However, the northern penetration of the Indian monsoon inland and its impact on hydrology and vegetation are only poorly understood because of the scarcity of continuous continental sedimentary archives. Here, we present the first continuous record of environment and climate in Southern Arabia, based on sedimentological, mineralogical, pollen and isotope studies of al-Hawa (Yemen) paleolake, which covers the time interval from 12 to 7.5 ka BP.