Some preliminary results from the Coropuna (Peru) ice core

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OBJECTIVE AND METHODS

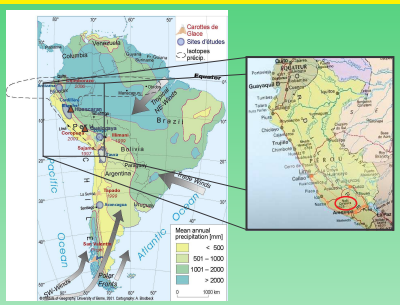
We present the results of a multiproxy study of the first 22m of an Andean ice core. The main objective is to reconstruct regional paleoclimate and identify sources affecting the site.

Materials:

- **42m long ice core** (6080m a.s.l.) extracted in June 2003

Analyses:

- **Water isotopes**: δ18O (0-10,5m) and δD(0-42m)
- **Trace and ultratrace** (0-22m)
- **Pollen** (0-42m)



DRILLING SITE

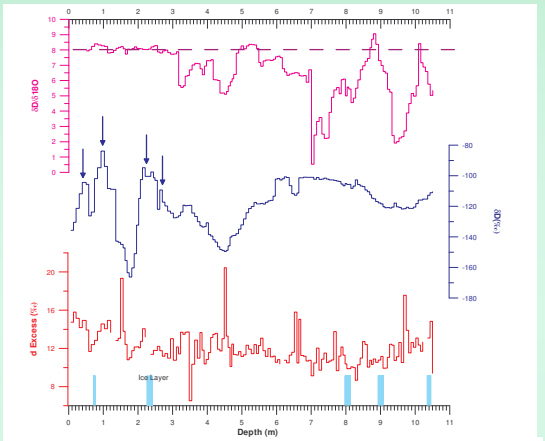
Coropuna (15º33'S, 72º36'W, 6377m)
Inactive volcano; Peruvian part of the Andes
Temperate glacier (Wagnon, 2003): -1,7℃ at 3,3m
Maximum precipitation (80 to 90%) during austral summer

RESULTS

DATING

The maximum Tritium fallout deposit related to the 1963/1964 nuclear weapon test was found at about 22 m. Therefore we calculate that the ice core spans the last century with an average accumulation rate of 0,58m.yr^{-1}.

WATER ISOTOPES



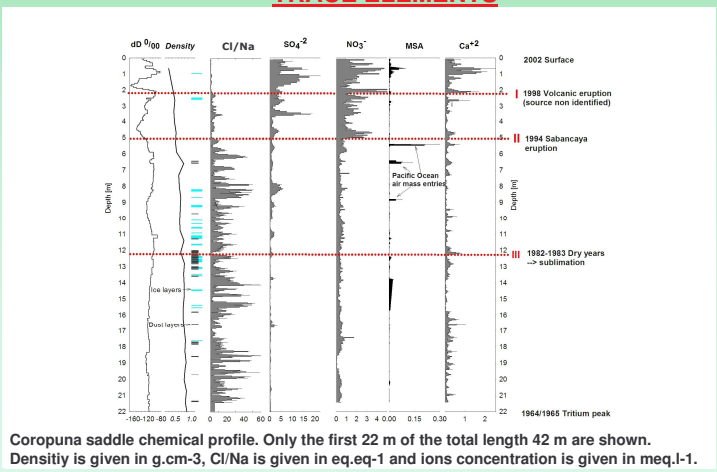
dD/d18O running slope over 11 points; dD of the ice; Deuterium excess d

• Seasonal variations are not identified below 3 meters. The isotopic signal may be disturb by postdepositionnal processes.

• The running δD/δ18O slope over 11 measurements (80 to 90cm) confirms trace of surface melting and evaporation below 3m. Indeed the evaporation line is generally close to 5 whereas the Global Meteoric Water Line (dashed line) is 8 (Dansgaard, 1963). However the isotopic signal seems to be not affected by these processes in the upper 3m where the isotopic variations remain large.

• The condensation of enriched water vapour in the firn and refreezing at the surface will increase the dExcess (Stichler, 2001). This process is not observed along the firn core because no specific values are found in the 5 ice layers showed in the figure. Evaporative process could be confirmed by the lowest dExcess value at 3,48m.

TRACE ELEMENTS



Coropuna saddle chemical profile. Only the first 22 m of the total length 42 m are shown. Densitiy is given in g.cm-3, Cl/Na is given in eq.eq-1 and ions concentration is given in meq.l-1.

• Even if Ca2+ may be affected by elution, the profiles that we have obtained show a well conserved signal for the cations. We can clearly identify seasonal dust layers in the first 10 m. Below this level, an increase of the peak number complicates the counting, suggesting either an accumulation rate change or the arrival of more than one seasonal input of eroded soils.

• As the isotopic signal shows, only the first 3 m may provide an unperturbed chemical signal. To identify the limit of a relatively intact chemical signal we use the chloride to sodium ratio (Cl/Na). we may expect that the principal sources affecting this site are located eastwards from the drilling site and the chemical signature is expected to be mostly continental. Average Cl/Na mass ratio in the upper 2 m of the ice core is 1.5 ± 0.2, which is closer to halite (Cl/Na = 1.4) than to sea-salt ratio (1.8), confirming that NaCl has a continental origin in this site.

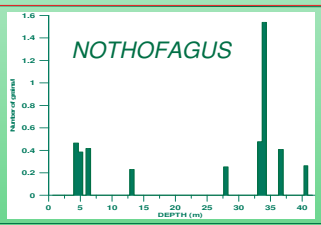
• A small tropospheric volcanic signal is observed at 2,1 m (high concentration of SO42- , Cl- and peaks of F- and H+, not shown) accompanied with a dust layer (red dotted line I). A larger volcanic event is observed at 5,0m (dotted line II), with the same characteristics mentioned above. Ca2+ layers point to 1994, a year when Sabancaya (active volcano situated 80km east from Coropuna) had one of its most important eruptions. Forward trajectories for Sabancaya's eruptions confirm that plume passed over the drilling site during May of this year.

• Dust layers between 12 and 12.5 m may correspond to a dry period around 1982-1983. The theoretical net accumulation of snow, calculated by subtracting measured daily sublimation from daily precipitation, predicts a reduced accumulation for this period. We expected high sublimation with concentration of non volatile species in the upper layers but it is not observed between 12 and 13 m (red dotted line III). Sublimation effects may have been diminished or erased by melt-water flow.

• In spite of remobilization of species, important peaks of methanesulfonic acid (MSA) - an indicator of marine biogenic activity - persist, showing evidence of secondary marine input from the Pacific Ocean.

POLLEN

The mountainous steppe characterized the vegetation on the Coropuna. In the ice core the most represented pollen is the ***Asteraceae*** forming the vegetation around the Coropuna. ***Podocarpus*** is characteristic of the rain forests distributed on the oriental slope of the Andes and is brought by the air masses coming from the **Amazon Basin**.
Nothofagus is distributed in Patagonia. The presence of these pollens on Coropuna glacier is a feature of an incursion of **polar front** coming from southern America (dry deposit in general). This discovery confirms a large scale circulation and the presence of incursions of polar front at high altitudes in the central part of the Andes.



CONCLUSION AND FUTURE WORK

- **Some particular events are recorded in the ice core, such as volcanic eruptions and dry periods. We give rise to polar front at high altitude in the study region.**
- **The isotopic and chemical signals are preserved between the surface and 3 m but they do not provide us climatic information on annual scale below 3 m. This study underline the melting of high altitude glaciers. The consequences on glaciers as environmental archive and water ressource are drastic. This would happen with a certain lag that depends on glacier meteorological conditions.**
- **In spite of post depositional processes observed, we can conclude that the Coropuna glacier is under strong continental influence, even though it is rather close to the Pacific Ocean.**
- **Comparaison with two other ice cores (summit and crater) extracted from the Nevado Coropuna in August 2003 and other Andean sites will complete this study.**

References

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