CLIMATIC AND CHEMICAL STUDIES IN JAMES ROSS ISLAND SNOW (ANTARCTIC PENINSULA)

(Abstract only)

by

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ABSTRACT

James Ross Island (mean diameter 50 km) is located near the north-eastern coast of the Antarctic Peninsula. An ice cap, covering nearly the entire island, rises to a height of ~1 600 m. Three summer expeditions with glaciological purposes were recently achieved on this ice cap by the Instituto Antártico Argentino, two of them with the scientific participation of the Laboratoire de Glaciologie et Géophysique de l'Environnement, Grenoble.

We present results of climatic and chemical investigations performed on recent snow layers dating back about 25 a. The studied samples were collected at different sites on the upper part of the ice dome. Detailed measurements (deuterium, oxygen 18 and total β activity) were performed on more than 1 000 selected samples. The relationship between stable isotope and mean annual temperature fits very well with the one previously obtained in the Antarctic Peninsula.

An ice core 22 m deep drilled on Dome Dalinger (elevation 1 600 m, mean annual temperature -15°C) showed well-preserved seasonal variations in deuterium all along the profile, thus providing a yearly dating of the samples which was confirmed by β activity reference levels. The mean annual accumulation thus deduced is 500 kg m^{-2} between 1955 and 1979, with values significantly lower (30%) in the 1955-65 decade than in 1965-79. The same trend earlier observed in east and central parts of Antarctica thus appears to have a very large geographical extent.

This well-dated core allows us to undertake a year-to-year comparison between isotopic and climatological data over the 1953-78 period. The mean annual values of the deuterium content are well correlated with the average surface temperature taken over the whole Antarctic Peninsula ($\delta D = (3.4 \pm 2.0)T - (98 \pm 32)$).

These data and the experimentally derived $\delta D/\delta^{18}O$ relationship obtained on James Ross Island allow us to deduce a $\delta^{18}O$ temperature gradient of $0.44‰°C^{-1}$. This low value is discussed in view of a new isotopic model taking into account the partial removal of precipitation and the possible variation of the oceanic source. James Ross Island thus appears suitable as a potential site for reconstructing past climatic changes of the Antarctic Peninsula beyond existing data.

Contamination-free techniques were used for sampling and analysing the snow samples. Na, K, Ca, and Al (by atomic absorption), H^+ (by titrimetric measurements), SO_4^{2-} and NO_3^- (by ion chromatography), and conductivity were determined on more than 100 samples collected in a 4.3 m deep pit. Some of these parameters were also measured on ice-core samples or additional pit samples.

Snow impurities are contributed by different aerosol sources: sea salt, continental particles and the small-size particles produced by the conversion of various atmospheric gases. The relative importance of these sources has been estimated.

James Ross snow was found always to be slightly acid (1 to 10 μEquiv. ℓ^{-1} of H^+, mainly as sulphuric acid). Nitrate concentrations are much smaller (0.4 μEquiv. ℓ^{-1}). Strong seasonal variations are observed for H_2SO_4 deposition, probably in relation to its formation in the Antarctic atmosphere.

Sea-salt deposition exhibits also seasonal variations which can be correlated with storm frequency in the Weddell Sea area. The continental aerosol contribution is weak as indicated by very low Al values.

The influence of Deception Island volcanism on the regional aerosol chemistry is examined. A marked increase of snow acidity was detected after the 1967 eruption of this volcano, but no ash layers were observed.

The strong variations of the conductivity of melt water are interpreted: it is shown that this parameter is not representative of the extent of sea ice.

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