

# NITRATE IN POLAR ICE

Eric W. Wolff  
British Antarctic Survey  
Natural Environment Research Council  
High Cross, Madingley Road  
Cambridge CB3 0ET  
UK

## ABSTRACT

Nitrate is one of the major impurities in polar snow, and is relatively easy to analyse. Large amounts of data therefore exist, including some from cores extending into the last glaciation. However, the data are not easy to interpret, and we do not yet have an adequate knowledge of even the present-day sources of nitrate to polar snow, nor of the deposition processes that control the concentrations seen. It is clear that anthropogenic pollution has increased the concentrations in Greenland snow by a factor of two in recent decades, and that no similar increase is seen in Antarctica. In pre-industrial Greenland ice, a clear seasonality allows annual layer counting. The sources in pre-industrial ice are probably lightning and/or the stratosphere, while soil exhalation may be an additional major component in Greenland. Whereas nitrate in Holocene ice is present as nitric acid, in ice from the last glaciation it is present as neutral salt, associated with terrestrial cations.

## 1. INTRODUCTION

The aim of ice core retrieval and analysis is to reconstruct past changes in some aspect of the atmosphere. This has been achieved rather successfully with some parameters, such as stable isotopes, mainly recording temperature (Dansgaard and Oeschger, 1989), the trace gases  $\text{CO}_2$ ,  $\text{CH}_4$  and  $\text{N}_2\text{O}$  (Khalil and Rasmussen, 1989), and dust (or Ca or Al) as markers of terrestrial material reaching drill sites (e.g. de Angelis et al., 1992).

NATO ASI Series, Vol. 130  
Ice Core Studies of Global Biogeochemical Cycles  
Edited by Robert J. Delmas  
© Springer-Verlag Berlin Heidelberg 1995

The major soluble impurities in Antarctic ice from the whole of the Holocene period are the sea salt ions, along with nitric and sulphuric acids. In Greenland, ammonia and a range of organic anions are also present (Legrand et al., 1992). Nitrate is an important part of the ionic budget across most of the polar ice sheets, representing 34 % (in  $\mu\text{eq}$  ratios) of the total anion content in recent snow from South Pole (Legrand and Delmas, 1984), and 43 % and 50 % of the inorganic anion content in recent snow and pre-industrial ice respectively from Summit, Greenland (Whitlow et al., 1992) (Fig. 1). In ice deposited in the last glaciation, nitrate was a smaller proportion of the total ionic content, because there was a far greater input of sea salt and terrestrial material in Antarctica (Legrand and Delmas, 1988b) and especially in Greenland (Hammer et al., 1985; Herron and Langway 1985).

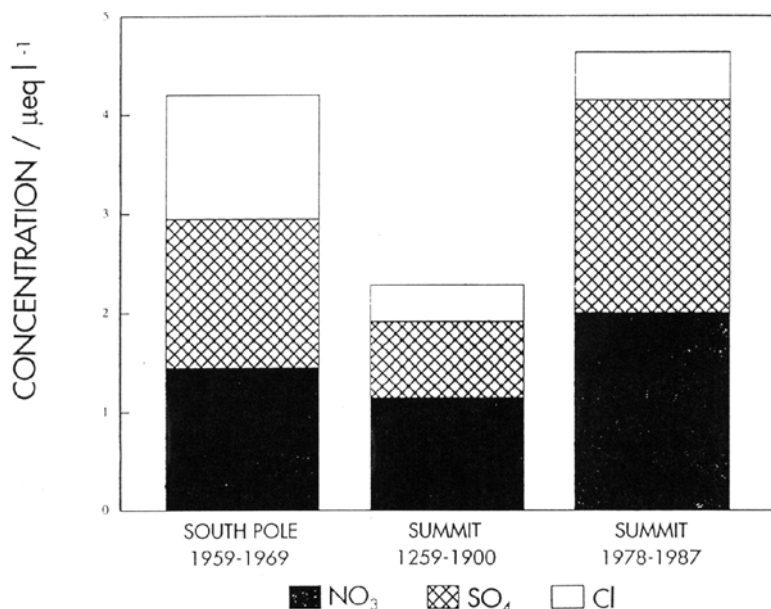


Fig. 1 The inorganic anion content at South Pole, Antarctica and at Summit, Greenland (pre-industrial and modern).

Because it is present in relatively high concentrations ( $10\text{--}100 \mu\text{g kg}^{-1}$  at most sites), and is rather easy to analyse with modern analytical techniques, large amounts of nitrate data exist