Traces of Icelandic Eruptions in the Greenland Ice Sheet

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ABSTRACT

The information in polar ice sheets on long range transported volcanic debris is discussed. Acidity data from the Greenland Ice Sheet are presented, which indicate a possible relation between the volcanic fall-out pattern on Greenland from a past eruption and the latitude zone of the eruption site.

A special presentation of the Icelandic eruptions Laki, 1783 A.D., Katla 1179 A.D., Eldgjá 934 A.D., Hekla I, III, IV and V is given.

Finally the potential of future volcanological research “via” the polar ice sheets is discussed.

INTRODUCTION

The importance of the polar ice sheets in research on past atmospheric composition stems from the fact that they consist of well layered frozen past precipitations. These individual precipitations are generally formed between the ice sheet surface and 1–2 km above it, which for the more central parts of the Greenland Ice Sheet corresponds to some 2.5–5.5 km above sea level. The special importance of the two major ice sheets – the Greenland Ice Sheet and the Antarctic Ice Sheet – relates to their vast extent, high surface elevations and remoteness from most aerosol sources. Not only does this secure a certain uniform mixing ratio of atmospheric trace substances, at levels where the precipitation forms, but it also keeps the impurity concentration in the snow very low.

The polar ice sheets are therefore unique “libraries” of past mid-tropospheric aerosol loads over a very broad latitudinal zone. The stratospheric and upper tropospheric impurities will add to the mid-tropospheric impurity load and in this way part of the upper atmospheric impurities is deposited on the ice sheets.

As volcanic eruptions inject substantial amounts of trace substances and gases into the troposphere and in many cases also into the stratosphere, it is not surprising that the ice sheets have proven to offer information on the amount and nature of long-range atmospheric transported volcanic products.

There are of course differences in this kind of information, which will depend on the site of information i.e. usually from a drill site on the ice sheet. The major differences between the Greenland Ice Sheet and Antarctica are for instance:

1) Antarctica reveals mainly eruptions in the southern hemisphere, while Greenland offers information on northern hemisphere eruptions.

2) Due to a greater precipitation in Greenland, as compared to Antarctica, the Greenland Ice Sheet can be dated to a higher accuracy by various stratigraphical methods; at least for the past 10,000 years.

3) During the Ice Age the aerosol load increased over both ice sheets, but while the Antarctic snow remained fairly clean and slightly acidic, the Greenland snow became alkaline and showed rather high impurity concentrations, as compared to present values. Loess and dust from the continental shelves added strongly to the mid-tropospheric aerosol load in the northern hemisphere.

Such large differences are not encountered, if we confine us to e.g. the Greenland Ice Sheet and the Holocene period: Then only moderate differences exist from site to site, but as will be seen later such differences offer additional information on the volcanic eruptions.

The possibility of extending tephra-chronology to the large ice sheets or ice caps remote from