

Cl, K, and Na Concentrations in Antarctic Snow and Ice

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Introduction. Absolute and relative concentrations of various elements in precipitation are subject to geographical variations which are sometimes very important [Eriksson, 1957, 1959, 1960; Junge, 1956, 1957; Junge and Gustafson, 1957; Junge and Werby, 1958; Sugawara et al., 1949]. These variations can be explained by some meteorological and geochemical hypotheses.

The present work supports these hypotheses. A hundred samples of precipitation, firn, and ice from Antarctica have been collected in Queen Maud Land by Dr. W. De Breuck, glaciologist of the 1960 Belgian Antarctic Expedition. The samples were obtained mainly in the vicinity of Base Roi Baudouin (70°26'S, 24°19'E), located on the ice shelf of the Princess Ragnhild Coast, 12 km south of the ice front.

Some of these samples came from a pit 16 meters deep, excavated at Base Roi Baudouin. They were collected to measure possible seasonal variations of salt content, which would be related to the nearness of the open sea. During the summer, the ice pack is open and the sea is relatively calm; in winter, on the contrary, the ice pack stretches over more than a thousand kilometers, interrupted only by a few channels of agitated sea.

The Antarctic continent is a region of great interest in geochemical research, being far from any human activity, and having preserved past precipitations, nearly without any melting, evaporation, or alteration after their deposition.

Analytic methods. Thus far, we have determined the Cl, Na, and K content of these samples. The results are given in Table 1.

Cl has been measured by an indirect colorimetric method, based on the exchange reaction: $2MCl_n + nAg_2CrO_4 \rightarrow 2nAgCl + M_2(CrO_4)_n$. The liberated CrO_4^{2-} radical is classically measured by colorimetry. Na has been determined by flame photometry; K by isotopic dilution

using a tracer enriched in the stable K^{40} isotope.

Mass spectrometry of one sample seems to reveal, besides Na and K, the presence of Li, Al, Si, Ca, Rb, and Sr. All these elements will be determined.

Conclusions. Cl concentrations decrease from the coast to the interior of the continent. Na concentrations follow the same pattern but increase in the mountainous area 300 km south of the coast. This may be interpreted as evidence of an appreciable regional influence. The 1.8 Cl/Na⁺ ratio of sea water was not found in any precipitation sample. This means either an important supply of nonmarine Na (even above the ocean) or a liberation of Cl. This latter hypothesis is not very likely, the solid state of precipitation above the Antarctic continent making all exchange reactions practically impossible.

The K concentration does not show any important geographical variation. The ratio of nonoceanic Na to nonoceanic K is about 2. This ratio could be that of the nonoceanic source of these two elements. A systematic study of other elements could tell us the nature of this source.

The Na concentration in the pit samples (varying between 0.5 and 2.5 ppm) does not show any seasonal variation on a time scale established by several stratigraphical observations (W. De Breuck, unpublished data) and confirmed by O isotope ratios. However, the conclusions about this variation are presently very uncertain because of the thickness of the measured samples.

An annual recurrence seems to be indicated by maximums of concentration, resulting perhaps from the long exposure time of the upper layers during the summer, causing some evaporation. It is probably not due to a higher content of Na in summer precipitations. This is not surprising, since the origin of Na is not ex-



TABLE 1. Average Results of Analyses of Samples Taken at the Same Place

Place	Latitude, deg	Cl ⁻ , ppm	Na ⁺ , ppm	K ⁺ , ppm	Cl ⁻	Cl ⁻	Na ⁺ n.m.*
					Na ⁺	K ⁺	K ⁺ n.m.
Ocean	68	2.33	1.54	0.25	1.47	12.47	2.21
Coast	70	2.06	1.92	0.38	1.05	5.63	2.80
Continent	70-72	0.47	0.56	0.17	0.88	3.07	2.16
Mountains	72	0.39	1.07	0.33	0.44	1.13	2.39

* n.m. = nonmarine.

clusively oceanic. However, we expect to be able to detect a seasonal effect by the study of the Cl content of the same samples.

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