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Impurity studies in 1000 year old Antarctic ice

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Volatile organic compounds contained in samples of about 1000 year old Antarctic ice have been analyzed by chromatography coupled with mass spectrometry (GC/MS). Halogenated hydrocarbons have been found, including dichloro-difluoromethane (Freon-12) (5 ppt), chloro-fluoroethene (15 ppt), 1-chloro-2-methylpropane (15 ppt), dichloromethane (120 ppt). No trichloro-fluoromethane (Freon-11) was found. Among other volatile impurities, acetonitrile (45 ppt) has been found in appreciable amounts. Comparative analysis of the Antarctic ice, usual water and distilled water samples has been carried out using emission and vibration spectroscopy. Sb has been found in the Antarctic ice in a concentration not less than 1.576 ppm. The nature of IR absorption spectra of the study objects is discussed. The data obtained point to non-technogenic origin of the compounds mentioned being potential destroyers of the atmospheric ozone layer.

Проведен хроматографический и масс-спектрометрический анализ легколетучих органических соединений в составе образцов антарктического льда имеющего возраст около 1000 лет. Обнаружены гологен углеводороды в том числе: дихлордифторметан (фреон-12) — 5 трлн$^{-1}$, хлорфторэтилен — 15 трлн$^{-1}$, 1-хлор-2-метилпропан — 15 трлн$^{-1}$, дихлорметан — 120 трлн$^{-1}$. Трихлорфторметан (фреон-11) в образце не обнаружен. Среди других летучих примесей в заметном количестве обнаружен ацетонитрил в количестве 45 трлн$^{-1}$. Методами емисионной и колебательной спектроскопии проведен сравнительный анализ состава образцов антарктического льда обычной и дистилированной воды. В антарктическом льду обнаружены элементы: Mg, K, Ca, Na, Si, Sb, S. Полученные данные свидетельствуют в пользу нетехногенного образования указанных соединений, которые являются потенциальными разрушителями озонового слоя атмосферы.

1. Introduction

Analysis of volatile organic compounds occluded in the Antarctic ice allows to recognize the evolution of the Earth atmosphere chemical composition occurring both in the course of natural climatic changes and due to anthropogenic factors. Besides of fundamental importance, such studies are of a great practical interest in the light of existing international agreements aimed at the reduction of technogenic effect on the environment. An unsatisfactory scientific substantiation for such agreements can result in many billions of losses or in negative ecological consequences. This concerns, in particular, to 1987 Montreal Protocol and agreements concluded in London (1991) and Copenhagen (1992). Those documents are aimed at the prohibition of production and use of chloro-fluorohydrocarbons (Freons) used widely in refrigeration industry as well as in some special industrial branches. The agreements mentioned have the task to stop the process of the ozone layer depletion resulting from the freon interaction with ozone in stratosphere under UV solar radiation. The origin of the ozone-destroying volatile organic compounds in the atmosphere and their concentrations remain at present still unclear.

In particular, the occurrence of freons in the Antarctic ice formed in pre-technogenic periods points that these substances could