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The evolution of CO_2 system on Mars: Transport from atmosphere to subsurface

T.N. KURAHASHI[1,2] AND E. TAJIKA[1]

[1] Department of Earth and Planetary Science, The University of Tokyo, Japan (kijun@eps.s.u-tokyo.ac.jp; tajika@eps.s.u-tokyo.ac.jp)

[2] Frontier Research System for Global Change, JAMSTEC, Japan.

Introduction

It is important to know the behavior of volatiles on Mars in order to understand the evolution of the climate of Mars. Especially, the evolution of CO_2 system on Mars is key to the problem because greenhouse effect of CO_2 may be one of the most important factors for the Martian environment throughout the history of Mars. The ratio of $^{13}C/^{12}C$ has been used to examine the behavior of CO_2 on Mars during its history. The $^{13}C/^{12}C$ ratio in the SNC carbonates shows a substantial fractionation with respect to juvenile magmatic carbon. These data strongly suggest that, following a substantial loss of carbon to space, the resulting fractionated carbon has been incorporated into crustal carbonate deposits [1]. However, the mechanism of substantial exchange of carbon between the atmosphere and the crust is still unclear. In this study, we propose new processes by which the atmospheric CO_2 could be transported and segregated into the depths of the underground.

CO_2 transport to the subsurface

If the Martian climate was really warm and wet owing to the greenhouse effect of CO_2 in the past, the atmospheric CO_2 pressure should have been high as much as several bars. The CO_2 in the atmosphere is considered to have decreased by removal processes such as impact erosion and sputtering of the atmosphere. Our numerical climate model suggests that the decrease in the atmosphere would have resulted in a runaway condensation of the atmospheric CO_2 into large CO_2 ice caps (climate jump). Our investigation of the CO_2 ice caps by using a numerical ice sheet model suggests that the temperature at the bottom of the CO_2 ice cap would exceed the melting point of CO_2 because of the thickness of CO_2 ice cap and the geothermal heat flux. If there were no H_2O ice below the CO_2 ice, liquid CO_2 produced by basal melting would permeate and diffuse directly into the subsurface through the pore. If there were H_2O ice below the CO_2 ice caps, the H_2O ice would melt and disappear by basal melting followed by permeation. The CO_2 removed from the surface might exist in the subsurface of Mars as clathrate, carbonate, and/or liquid and gaseous phases today.

References

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6.3.P10

Precambrian Antarctic Meteorite *"Phantasia"*

T. TANAKA[1], M. MINAMI[1], S. SHIBATA[1], K. YANAI[2] AND K. SHIRAISHI[3]

[1] Dept. Earth & Environmental Sci., Nagoya Univ., Chikusa, Nagoya 464-8602, Japan (tanaka@eps.nagoya-u.ac.jp)

[2] Dept. Civil and Environmental Engineering, Iwate Univ.

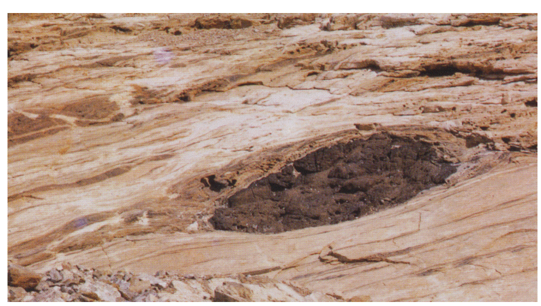
[3] National Inst. Polar Research

More than 22000 meteorites are listed in Grady (2000). Most of the stony meteorites, however, classified into only three groups, H, L and LL. The each group seems be correspond to a mother celestial body. The temporal variation of the meteorite groups will provide us various hints on "tectonics of the solar system", like Swedish Ordovician meteorites.

We know many meteorites on the Antarctic ice. We also know many curious mafic and ultramafic nodules in the Lütsow-Holm Complex, East Antarctica as shown below. Many mafic rocks of a few meters or smaller are included in the Complex. The Complex is metamorphic rock originated from sedimentary rocks of upper Proterozoic. The source of these mafic rocks was not found yet. Antarctic geologists regard that the nodules were derived from "Extinct hinterland" (Hiroi et al., 1986). We examined another possibility that a part of the metamorphosed mafic rocks originated in Proterozoic meteorites, which need no geological hinterland.

Thirty mafic and ultramafic nodules were examined for 28 elements including REE and PGE by INAA. GSJ reference JB-1 and PGE reagents were use as standards. Allende powder was also analysed as a reference. Several mafic rocks have "chondritic" REE pattern. The platinum group elements, which are contained in meteorite more than 10000 times of the crustal rocks, must be a good indicator. No more than one ppb of Osmium and Iridium was identified in the mafic and ultramafic nodules though the Allende reference gave appropriate numbers.

It is the custom for the meteorite to be named the place where it falls on. The Precambrian Antarctic meteorite falls in our mind. Then it was named as ***"Phantasia".***



A mafic nodule in the Lütsow-Holm Complex, Antarctica. (Photo by Yanai, 1992)