Geophysical Research Abstracts, Vol. 7, 05532, 2005
SRef-ID: 1607-7962/gra/EGU05-A-05532

The possible role of CO_2 hydrates for terra-forming processes on Mars

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CO_2-hydrate is a possible constituent of the Martian regolith. Likewise, CO_2-hydrate is assumed to occur in the ice layers of the north and the south polar caps. High CO_2 hydrate contents in the cap will lower the heat flow and affect in this way the process of their basal melting. Moreover, some authors suggest that a fast decomposition of subsurface CO_2 hydrate, driven by some catastrophic event (such as meteorite impacts or volcanic eruptions) is the reason for the formation of the chaotic terrains and outflow channels, pancake-dome structures and northern plain deposits.

To provide a better basis for these ideas a number of experiments for CO_2 hydrate formation and decomposition were performed in the laboratory mimicking Martian surface and sub-surface conditions. Due to the abundances and distribution of $CO_2$and water and according to the respective stability of the condensed phases under Martian conditions the most likely scenario for the formation of CO_2 hydrate is a reaction of gaseous CO_2 with water ice. The experiments indicate that the time for formation critically depends on the accessible surface area of the ice grains. Applying a new phenomenological model for gas hydrate growth and decomposition, values for the rate coefficients for the different reactions were obtained. We are now able to predict the formation and decomposition kinetics over a large range of pressure and temperature. Moreover, we have established an unexpected behaviour upon decomposition: In a temperature interval from about 240 to 273 K the decomposition is anomalously slowed down leading to a phenomenon of “self-preservation” of CO_2 hydrate outside the thermodynamic stability field. We will discuss the importance of this unusual decomposition kinetics for various suggested terra-forming processes on Mars.