Theoretical and experimental studies of the kinetics of Ca/Mg-rich carbonates in an astrobiological context.

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Abstract

The detection of carbonates on the surface of several bodies of our Solar System, for example on Mars surface or on the surfaces of minor bodies, like Ceres, has become more frequent in the last years, also thank to the advancement of technology in the design of space missions.
The thermal decomposition kinetics of Ca/Mg-rich carbonates is studied by means of theoretical and experimental methods, in connection to the transport of extraterrestrial organic matter to Earth and the possible use of the decomposition reaction in the characterization of these minerals in space.

Model results show that the atmospheric entry of Ca/Mg-rich carbonate grains is strongly affected by their thermal decomposition. The decomposition reaction, being strongly endothermic, tends to decrease the grain temperature during the atmospheric entry, especially at high altitudes.

In view of its importance, the decomposition reaction is studied using several tools: kinetic model for chemical composition and entry models coupled with experimental (spectroscopic and gravimetric) analyses.
Previously, it was found that the proposed infrared spectroscopic technique to evaluate the degree of advancement of the reaction is in good agreement with gravimetric measurements for calcium carbonate. These experimental results were interpret using the numerical model developed for the atmospheric entry scenarios: the analysis had highlighted the need of an additional contribution to the reaction enthalpy to reproduce the experimental results, suggesting that the present theoretical model needs improvements such as the account of gas diffusion in the materials.

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