MODELING THE GAS FLUX FROM A JUPITER-CLASS COMET NUCLEUS

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Sublimation and gas flux of volatile ices from porous bodies in the Solar System are important, observable phenomena. Surface erosion and dust build-up on a comet nucleus and coma formation are processes attributable to the flux of sublimating gases. Our computer simulations focus on the gas flux from volatile, icy components in the surface layer of a porous, Jupiter-class comet in order to investigate the relationship of the observed relative molecular abundances in the coma with those in the nucleus. We compare results from one-dimensional and two-dimensional models. We assume a porous body, containing dust and up to four components of ice (e.g., H_2O, CO, CO_2, CH_4). For details of the one-dimensional model see [1]. We solve the mass and energy equations for the different volatiles simultaneously. The model includes inflowing and outflowing gas within the body, dust mantle build-up, depletion of the most volatile ices in outer layers, and recondensation of gases in deeper layers. The model calculations start with a homogeneously mixed body at a constant temperature and a constant mass density at aphelion of the orbit. Due to insolation and heat conduction the internal energy of the body increases. As a result of sublimation of the minor, more volatile components, the initially homogeneous body differentiates into a multi-layered body. For example a dust, H_2O, CO_2, and CO ice body differentiates into a four layer body, in which the deepest layer has the original composition and the higher layers are successively more depleted of volatiles. The boundaries between the layers are sublimation fronts of the corresponding volatile phases. The depths of the sublimation fronts change with time and are on the order of tens of meters. From the calculations we obtain temperature, relative chemical abundance, porosity, and pore size distributions as a function of depth, and the gas flux into the interior and into the coma for each of the volatiles at various positions of the comet, in its orbit. We find that a dust layer at the surface of the nucleus drastically reduces the sublimation flux of H_2O at heliocentric distances $r < 3$ AU. The ratio of the gas flux of minor volatiles to that of H_2O in the coma varies by several orders of magnitude throughout the orbit.

We developed a two-dimensional model for heat and mass transfer to investigate inhomogeneities, surfaces with different shapes, and surface structures. We present preliminary results from this model for the gas and dust flux and for the temperature and abundance distributions in the surface layers of the nucleus as a function orbital and structural variations. These computer simulations will be useful for engineering models for spacecraft missions subsequently for the interpretation and understanding of *in situ* results.

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References

[1] Benkhoff, J. and Huebner, W. F. (1995) *Icarus*, *in* press.

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