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Characterization of the Subsurface of 67P/Churyumov-Gerasimenko's Abydos Site

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Abstract

We investigate the structure of the subsurface of the Abydos site using a cometary nucleus model with parameters adapted to comet 67P/Churyumov-Gerasimenko and the Abydos landing site. We aim to compare the production rates derived from our model with those of the main molecules measured by Ptolemy. This will allow us to retrieve the depths at which the different molecules still exist in solid form.

1. Introduction

On November 12, 2014, *Rosetta*'s descent module *Philae* landed on the Abydos site of comet 67P/Churyumov-Gerasimenko (67P). Among the instruments onboard *Philae*, the Ptolemy mass spectrometer performed the analysis of several samples collected from the surface and atmosphere of the comet. Here we investigate the structure of the subsurface of the Abydos site. To do so, we employ a cometary nucleus model with an updated set of thermodynamic parameters relevant for 67P. Appropriate parameterization of the illumination at the Abydos site is also used. The comparison of the production rates derived from our model with those of the main molecules measured by Ptolemy should allow us to place important constraints on the structure (layering and composition) of the subsurface of *Philae*'s landing site.

2. Model and Parameters

We used the one-dimensional cometary nucleus model developed by [1]. The model considers an initially homogeneous sphere composed of a predefined porous mixture of ices and dust in specified proportions. It describes heat transmission, gas diffusion, sublimation/recondensation of volatiles within the nucleus, water ice phase transition, dust release, and mantle formation. This model takes into account all phase changes of water ice known in a cometary nucleus: amorphous ice, crystalline ice and clathrates. In the present study, we assumed that the nucleus is made of crystalline ices (H_2O, CO and CO_2) mixed with dust. Based on the recent *Rosetta* ROSINA observations [2], we also assumed CO/H_2O = 0.13 and CO_2/H_2O = 0.08 in the nucleus. Other key parameters have been derived from recent 67P studies: the dust/ice mass ratio is now assumed to be 4 [3], instead of being set typically to ~1, and the porosity of the nucleus is now 65% [4].

3. Results and Conclusions

Figure 1 represents the evolution of the ratio between CO and CO_2 that outgas throughout the surface of the Abydos site as a function of the orbital evolution of 67P. After the first orbital evolution, the outgassing rates of the different molecules follow the same trend at Abydos, irrespective of the considered period. The CO/CO_2 ratio varies over several orders of magnitude, depending on the comet's position on its orbit. The outgassing of CO_2 is more important when 67P arrives at perihelion, but the trend reverses once perihelion is reached and the outgassing of CO becomes dominant (peaks that can be seen at perihelion are induced by diurnal changes of insulation, which are significant at this period of the orbit). The next step of our study will consist in comparing our results with the production rates of molecules measured by Ptolemy at the Abydos landing site. By doing so, this will allow us to retrieve the depths at which the different molecules still exist in solid form.

4. Figures

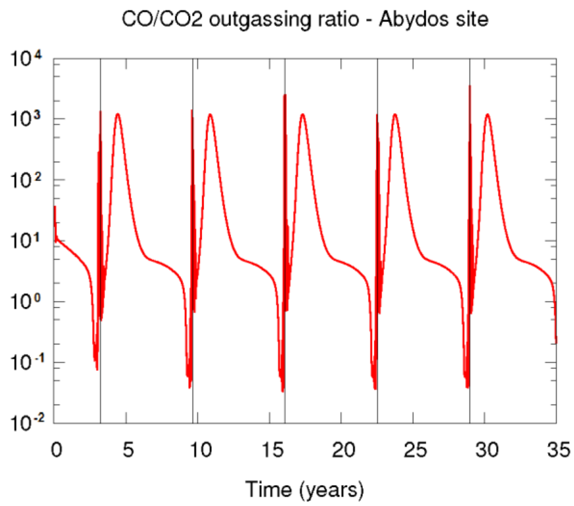

Figure 1: Evolution of the CO/CO_2 ratio at the Abydos landing site during 35 years of orbital evolution. Vertical lines correspond to the passages of the comet 67P at perihelion.

References

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