

Heterogeneous interaction of volatile organic compounds with natural mineral dust surfaces under simulated atmospheric conditions

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Mineral dust is a key component of atmospheric aerosols. According to recent estimations, every year, 1600 Tg of mineral dust is released into the atmosphere, representing the largest mass emission rate of particles at a global scale (Satheesh and Krishna, 2005), Andreae and Rosenfeld, 2008). Dust surfaces provide the seedbed for specific interactions with trace gas molecules, and therefore, can play a key role in the transformation and environmental fate of many atmospheric species. The heterogeneous processes of mineral dusts and their components with atmospheric trace gases have generated a great deal of interest over the past 15 years. However, there is a significant lack of laboratory data regarding the interaction of volatile organic compounds (VOCs) with mineral dust. These heterogeneous processes may have strong effects on the chemical composition of the troposphere altering (i) the physical and chemical properties of the particles, (ii) the oxidative capacity of the troposphere, and (iii) the budget of reactive gases such as VOCs and NO_x that are key players in the formation of secondary pollutants (such as ozone), and the formation of secondary organic aerosols (SOA).

The main objective of our study is to investigate the kinetics and mechanism of VOC heterogeneous interactions with natural mineral dust under simulated atmospheric conditions. Currently, the research is focused on the reaction of 2-propanol, toluene, limonene and isoprene with natural Saharan and Asian mineral samples (Romanias *et al.*, 2016). The kinetic and mechanistic studies are performed using a novel experimental setup combining long path transmission Fourier-Transform InfraRed spectroscopy (FTIR) and Selected-Ion Flow-Tube Mass Spectrometry (SIFT-MS) for the detection of the gas-phase species. When necessary, the adsorbed phase is monitored employing Diffuse Reflectance Infrared Fourier Transform spectroscopy (DRIFTS). The uptake coefficients, γ , and the adsorption isotherms of the studied VOCs are measured as a function of several environmental parameters (gas-phase concentration, temperature, relative humidity, mineral dust mass). For instance, Figure 1 summarizes the adsorption isotherms of 2-propanol on Gobi dust over a wide temperature range. Beside the kinetics, a series of experiments was conducted to investigate the degradation of the selected VOCs (a) under UV light conditions and (b) in presence of O₃ and to quantify the yield of the products formed.

In order to interpret the results thoroughly and comprehensively, physicochemical properties of the natural samples were characterized and are presented in more details in a companion abstract. N₂ sorption

measurements, granulometric analysis, X-ray Fluorescence and Diffraction (XRF and XRD) measurements helped to determine the specific surface area, the particle size distribution and their chemical composition, respectively. The obtained results could be later used in box models and global chemistry-transport (GCT) models to evaluate the impact of VOC-mineral dust interactions on atmospheric processes and climate change.

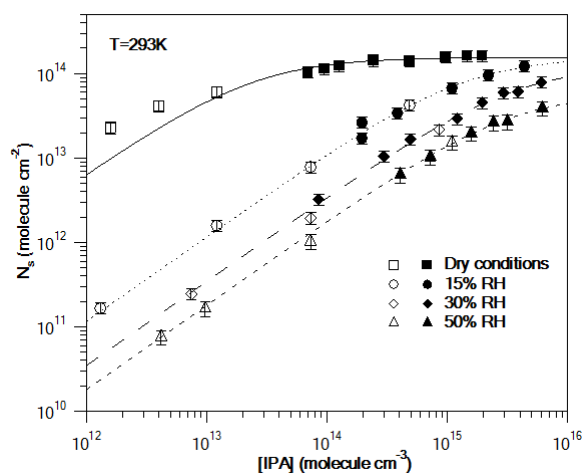


Figure 1. Adsorption isotherms of IPA on Gobi dust.

Open symbols: experiments with SIFT-MS; filled symbols: experiments with long path FTIR. The lines are fits of the data according to the Langmuir expression.

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