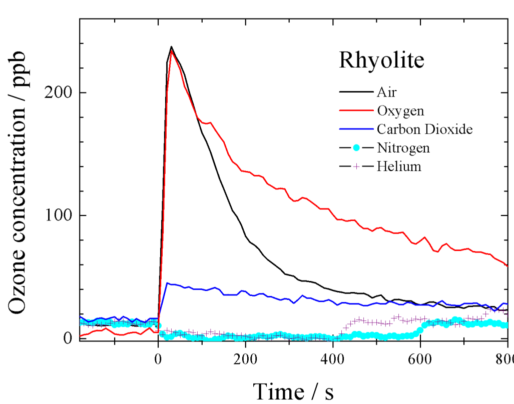
OZONE PRODUCTION BY COLLIDING DUST IN THE MARTIAN ATMOSPHERE. Raúl A. Baragiola and Catherine A. Dukes, University of Virginia, Laboratory for Atomic and Surface Physics, Charlottesville, VA 22904. raul@virginia.edu, cdukes@virginia.edu

Introduction: Ozone is the most active species in the Martian atmosphere. First detected by absorptions of the Hartley band in the UV as well as IR features, it has been observed over the course of 40 years, from Mariner 7 & 9 to Hubble, SPICAM (on Mars Express), and HIPWAC at Mauna Kea. Martian ozone is thought to be produced by photodissociation of CO_2 and O_2, followed by O-O_2 association, and be destroyed by odd hydrogen from water photolysis [1, 2]. The photochemical models predict successfully many aspects of the spatial and temporal variability of ozone but underestimate the ozone abundance at low latitudes during aphelion, suggesting the existence of additional processes [2].

Ozone from triboelectricity: An additional mechanism for ozone production follows from our recent discovery of ozone resulting from the fracture of a variety of rocks in gases containing oxygen, such as air, O_2 and CO_2 [3]. Fracture leads to electrostatic charging (triboelectricity) by charge separation, with associated large electric fields that produce dielectric discharges in the gas surrounding the fractured surfaces. We propose that colliding dust particles in the Martian atmosphere, especially during storms, will generate ozone through a similar mechanism in the ambient CO_2.

The figure shows the result of experiments with rhyolite, an igneous rock [3]. Fracturing was done with a 7.1 mm silicon carbide grinding stone attached to a vertical high-speed (30 k rpm) Dremel. The rocks, fixed in a PTFE jig, were abraded for 260 seconds inside a ~5L chamber, after which the chamber atmosphere was pumped into the ozone detector through particle filter. Initially, the ozone signal increases due to the transit time of the gas to the detector, then peaks and decays as gas is pumped from the chamber. The decay time constant is ~300 s, determined by the chamber volume, pumping speed, and adsorption/desorption plus reactions from walls, the sample, and rock fragments. Ozone is formed from oxygen containing gas, such as air, CO_2 and O_2, but not in nitrogen or helium gas, showing that it does not originate from oxygen in the rocks.



Dust charging in Mars: Electrostatic charging by colliding dust were demonstrated in simulated Mars conditions by Eden & Vonnegut [4], who agitated dust in a glass flask containing 10 mTorr of CO_2 and ob served sparks. Electrical discharges are observed during dust storms on Earth with electric fields that can exceed 100 kV/m [5]. There is intense activity in modeling the effects of dust charging in Mars' atmosphere [see, e.g., [6-10]] with the largest unknown being the actual charging mechanism and the magnitude of the charges and electric fields.

Implications: The ozone produced in dust storms and dust devils will contribute to the general oxidizing ambient on Mars, in addition to H_2O_2 [11]. In addition, electrical discharges in dust collisions will set up chemical reactions that will produce other molecules, besides ozone. Reactions of dissociation products of CO_2 with minor components of the atmosphere can produce or alter the abundance of other observed gases, such as methane, that could be mistaken for products of biological processes. Electrical discharges at dust storms could also cause the reported unexplained loss of methane [12]. All such processes should be considered in exobiological analyses [11, 13, 14].

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