NITRATE AND PERCHLORATE FORMATION BY LASER ABLATION OF SODIUM CHLORIDE IN SIMULATED MARTIAN ATMOSPHERES. IMPLICATIONS FOR THEIR FORMATION IN DUST DEVILS BY ELECTRICAL DISCHARGES. X. Walls[1], R. Navarro-González[1], P. U. Martínez-Pabello[1], J. de la Rosa, P. Molina. [1]Laboratorio de Química de Plasmas y Estudios Planetarios, Instituto de Ciencias Nucleares, Universidad Nacional Autónoma de México, Circuito Exterior, Ciudad Universitaria, Apartado Postal. 70-543, Coyoacán, Ciudad de México 04510, México. (xwallsp@gmail.com & navarro@nucleares.unam.mx).

Introduction: Nitrates and perchlorates have been found in the Martian surface by the Mars Science Laboratory (MSL) Curiosity rover using the Sample Analysis at Mars (SAM) instrument [1,2]. The presence of nitrates on the Martian soil implies that nitrogen in the atmosphere was either fixed in the past when liquid water flowed on Mars or that it is currently being fixed under present Martian conditions. This kind of nitrogen bearing-salts could be an important nitrogen source for past or present life on Mars. It has been demonstrated that some important pathways for nitrogen fixation may have been the collision of bolide impacts and electrical discharges producing gaseous nitrogen oxides [3].

Perchlorates are important chemical species on Mars as they have been found widespread across the its surface. They were found on the Martian Artic soil by the Phoenix mission [4]. Its presence is inferred at the Viking landing sites by the detection of chlorinated hydrocarbons [5]. They were found on the Gale crater by the SAM instrument [1]. And it has been suggested that Recurring Slope Lineae (RSL) show evidence of oxychlorine salts in their IR spectra [6]. Several mechanisms for their formation have been suggested such as photochemistry and radiolysis [7, 8, 9].

Mars currently has an intense aeolian activity involving the production of sandstorms and dust devils [10]. It has been theorized that triboelectricity forms inside of them by frictional activity producing charged particles [11]. The electric fields produced by this phenomena may produce electrical discharges oxidizing atmospheric nitrogen and chloride salts [12].

The aim of the present study is to test if nitrate and perchlorate can be produced at the same time by a mechanism involving electric discharges simulating triboelectricity in dust devils. This could demonstrate that electrification of Martian dust could be an additional mechanism for the oxidation of chlorine and nitrogen on Mars.

Methods: A pure sodium chloride plate was placed inside of a glass reactor. The gases were evacuated and the reactor was refilled with two simulated Mars atmospheres: 66% CO_2, 33% N_2, 1% Ar and 96% CO_2, 2% N_2, 2% Ar. The sodium chloride plate was impacted by a pulsed laser (Nd:YAG source). The condensed dust was analyzed by a wide set of analytical techniques: Fourier transform infrared spectroscopy (FTIR), visible spectroscopy using azo dyes, simultaneous thermal analyses (TGA/MS/DSC), powder Xray diffraction (PRXD), and ion chromatography (IC). The results were compared with a thermochemical model.

Results and Discussion: The main component of the condensed dust was sodium chloride (NaCl ≥91.5%) which means that the process was unable to transform sodium chloride efficiently. Sodium nitrate and sodium perchlorate were produced in minor quantities ($NaNO_3$ = 1.6-6.0%), ($NaClO_4$ = 0.2-0.3% respectively). The experimental NO_3^-/ ClO_4^- ratio was estimated to vary between 5.0 to 30.0 meaning that nitrates were formed in a greater abundance than perchlorates. The experimental ratio represents a high value compared to that found on Mars where perchlorates prevail over nitrates [13].

Conclusions: The salts were directly formed without the presence of water which suggests that this mechanism could be relevant for the present Martian conditions (dry, cold and dusty). The high experimental ratio suggests that the species formed by triboelectricity inside dust devils may not be directly linked to the source of perchlorates found in Mars. This mechanism may be a source for perchlorate formation where metal chlorides are injected to the atmosphere by a sudden heating of the dust in the discharge channel, followed by their photochemical oxidation.

Acknowledgments: We gratefully acknowledge the Universidad Nacional Autónoma de México (PAPIIT IN111619 and PAPIME PE102319) for financial support.

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