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Martian soil-nitrogen may be sampled by the Mars meteorites

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Nitrogen is an important biogenic element, second only to carbon in its central role in living organisms. Thus, the search for life on Mars must address the issue of N presence and availability on this planet. The Martian planetary endowment of N is not well constrained and estimates vary within wide limits. Atmospheric nitrogen was measured by Viking and was found to be present at a concentration of 2.7%. However, no direct analysis of N concentrations was done yet in Mars soils and surface rocks and the question of the presence, amount and availability of N in the lithosphere and pedosphere of Mars is still wide open. As a result N on Mars remains an enigma. Planned future rover missions such as NASA's MSL and ESA's ExoMars, do not include dedicated instrumentation that will analyze the surface nitrogen content in detail. Are we going to continue to be ignorant about N in Mars soil for another decade?

We hypothesize and will show that the Mars meteorites (the SNCO clan) may contain also indigenous, non atmospheric soil nitrogen. We suggest and test the hypothesis that nitrogen and noble gases were captured in the meteorites at their atmospheric proportions during the impact that lead to the ejection from Mars, but that the meteorites contain also elemental contributions from the surface solid phases. As such, these meteorites constitute a 'returned sample' from the surface of Mars that may help in constraining the concentrations and availability of this important biogenic element on Mars.

To test this hypothesis we developed a calculation algorithm that estimates and reconstructs the Captured Atmosphere Volume (CAV, at Mars ambient standard T and P conditions in units of cm^3 STP_M gas g^{-1}meteorite) and assessed the excess N. We use for the computations Mars atmospheric mixing ratios and published data of measured concentrations of nitrogen and noble gases released from Mars meteorite samples by stepwise heating at temperatures above 500^oC, thus minimizing potential contributions of terrestrial contamination.

We calibrated the calculation algorithm using published concentration data of captured Mars gases in Mars meteorite shergottite EETA 79001 (glass lithology) and calculated the captured volume of Mars atmosphere, at Mars ambient standard T and p conditions (STP_M) based on 7 different atmospheric constituents. The calculated CAV using the concentrations of the different gaseous constituents was very similar, averaging 0.331 $\pm$0.106 cm^3 STP_M g^{-1} meteorite mass. Further, it had relatively low standard deviations between replicates for a given constituent (CV% of 6 to 45%). This shows that the major, if not the sole, source of the carbon, nitrogen and noble gases found in the EETA 79001 glass lithology sample was the Mars atmosphere. Calculations employing a large database of several hundred published meteorite analyses show that CAV computed from the concentrations of released isotopes of the noble gases Ar, Kr and Xe averaged 0.117 $\pm$ 0.127 cm^3 STP_M g^{-1}. Contrary to this, CAV computed from released-nitrogen results was two orders of magnitude higher, averaging 12.8 $\pm$ 20.6 cm^3 STP_M g^{-1}, an unrealistically-high captured atmospheric volume. The high N-based CAV can be explained by, and strongly suggests, the presence of excess meteoritic N due to inclusion of indigenous soil N, added as N salts, minerals and trace organics to the small amount of gaseous N captured from the atmosphere during the ejection-impact event.