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Search for nitrates on Mars by the Sample Analysis at Mars (SAM) Instrument

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One of the main goals of the Mars Science Laboratory is to determine whether the planet ever had environmental conditions capable of supporting microbial life. Nitrogen is a fundamental element for life, and is present in structural (e.g., proteins), catalytic (e.g., enzymes and ribozymes), energy transfer (e.g., ATP) and information storage (RNA and DNA) bio-molecules. Planetary models suggest that nitrogen was abundant in the early Martian atmosphere as dinitrogen (N_2). However, a fraction of N_2 has been lost to space by sputtering and photochemical processes [1, 2], impact erosion [3], and chemical oxidation to nitrates [4, 5]. Nitrates produced early in Mars' history by photochemistry may later decompose back into N_2 by the current impact flux [6]. It is estimated that the Martian surface could contain soil nitrates at levels of 0.3 wt.% N, if mixed homogenously [6], or a layer of pure $NaNO_3$ of about 3 m thickness [5] distributed globally. Nitrates are a fundamental source for nitrogen for terrestrial microorganisms. Therefore, the detection of soil nitrates is important to assess habitability in the Martian environment. The only previous attempt to search for soil nitrates was by TEGA and the MECA WCL on the Phoenix mission but no evolved N-containing species were detected [7]. Nitrates have been tentatively identified in two Martian meteorites: Nakhla [8] and EETA79001 [9]. SAM is capable of detecting nitrates by their thermal decomposition into nitric oxide, NO. SAM analyzed samples from Rocknest soil and two drill holes located at John Klein (JK) and Cumberland (CB) mudstones in the Sheepbed member of the Yellowknife Bay formation in Gale Crater. There appear to be several peaks associated with the release of m/z 30 in the temperature range from 150˚C to 600˚C. m/z 30 can be attributed to nitric oxide; however, other possible chemical interferences may be present and are assessed. The origin of nitric oxide is discussed and its thermal evolution is compared with analog studies of mixtures of nitrates and perchlorates [10].

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